ILLINOIS TECH ENGINEER

7657

OCTOBER, 1947

"Experience is the Best Teacher!
in aerial acrobatics—and in smoking too," says ROSE GOULD, aerial sensation of the Big Top
SHE'S 75 FEET UP—WITH NO NET BELOW! IT'S THE MOST DARING AERIAL ACT I'VE SEEN YET!
ROSE GOULD HANGS BY HER HEELS — WITH NO OTHER SUPPORT AND NO NET — IN A STUNT THAT MAKES EVEN VETERAN CIRCUS HANDS BLINK!
YES, SHE FELL ONCE — CABLE BROKE — THIS IS HER FIRST APPEARANCE SINCE
SHE'S GETTING READY FOR THE DIVE NOW
WITH NO NET...
...SHE DIVES INTO SPACE!
THREE FEET FROM THE GROUND!
R. J. Reynolds Tobacco Company, Winston-Salem, North Carolina
I'VE SEEN THRILLING PERFORMANCES, MISS GOULD — BUT NOTHING TO MATCH YOURS
HAVE A CAMEL — AND TELL US HOW YOU DEVELOPED THOSE STUNTS
I LEARNED FROM EXPERIENCE ... JUST AS I LEARNED FROM EXPERIENCE THAT CAMEL IS THE CIGARETTE FOR ME
I SMOKED MANY BRANDS DURING THE WARTIME CIGARETTE SHORTAGE — CAMELS SUIT ME BEST!
Rose Gould
Featured aerialist of Ringling Bros. and Barnum & Bailey Circus
Your "T-ZONE" will tell you... T FOR TASTE... T FOR THROAT... That's your proving ground for any cigarette. See if Camels don't suit your "T-ZONE" to a "T"
CAMEL
TURKISH & DOMESTIC BLEND CIGARETTES
CHOICE QUALITY
MORE PEOPLE ARE SMOKING Camels THAN EVER BEFORE

Contributors . . .

Linton E. Grinter, research professor of civil engineering and mechanics at Illinois Tech, has gained wide recognition for his work in structural engineering. He received his bachelor's and civil engineering degrees at the University of Kansas and his master's degree and doctorate at the University of Illinois. He served as professor of structural engineering at Texas A & M college from 1929 until 1937, when he joined the staff of Armour Tech. He has held the positions of dean of the graduate school and vice president of Illinois Tech. Dr. Grinter has published five books on structural analysis and design and has written numerous articles on indeterminate structures. His essay, "The Education of Engineers for Latin America", appeared in the March, 1947, *Illinois Tech Engineer.*

Alfred C. Ames is assistant professor of English at Illinois Tech. He received his bachelor's degree at the University of Kansas and his master's degree and doctorate at the University of Illinois. He taught at Illinois from 1937 until 1944, when he joined the staff of Illinois Tech. Dr. Ames' articles have been published in *Poetry, ETC.: A Review of General Semantics, Modern Language Notes,* and the *Journal of Engineering Education.*

Roy D. Haworth, Jr., is supervisor of foundry process research of Armour Research Foundation. A graduate of Massachusetts Institute of Technology in 1939, he was associated with the Ingersoll-Rand company, Phillipsburg, N. J., for two years as metallurgist and chief metallographer. In the early war years he held a position with the Wyman-Gordon company, Harvey, Ill., and in 1943 he became chief metallurgist for the Lehigh Foundries, Easton, Pa. Mr. Haworth joined the staff of

(please turn to page 4)

COVER PICTURE — John J. Gilman, graduate student who lives at 1516 Birchwood street, Chicago, uses the heat treating and hardening furnace in the metallurgical engineering laboratory.

VOLUME 13 NUMBER 1 OCTOBER, 1947

ILLINOIS TECH ENGINEER

In this issue

Published October, December, March and May.
Subscription rates, $1.50 per year.
Editorial and Business Office, Illinois Institute of Technology,
3300 Federal St., Chicago 16, Illinois.

(continued from page 3)

Armour Research Foundation in 1946.

William C. Wick joined the staff of Armour Research Foundation in 1940. Previously, he had been an organizer and charter member of the Junior Foundrymen of America. From January, 1944, to February 1946, he served in the United States Navy and was assigned to the Naval Research laboratory, where he started and developed the use of insulated risers for non-ferrous castings. Now serving as an assistant metallurgist, Mr. Wick has written for trade publications and has presented a paper before the annual convention of the American Foundrymen's association.

Herbert A. Simon is professor and chairman of the department of political and social science at Illinois Tech. He received his bachelor's degree and doctorate at the University of Chicago. From 1939 to 1942 he was associated with the University of California. He joined the Illinois Tech staff in 1942. Dr. Simon is consultant to the International City Managers' Association, Institute for Training in Municipal Administration, the United States Bureau of the Budget, the United States Census Bureau, and the Cowles Commission for Research in Education. He has published numerous articles and monographs. His essay, "What is Urban Redevelopment?", appeared in the December, 1946, *Illinois Tech Engineer.*

Otto Zmeskal, professor and director of the department of metallurgical engineering at Illinois Tech, has done outstanding research in the fields of aluminum alloys and radiography. Dr. Zmeskal at one time served as the director of a program sponsored by the Engineering Foundation and the American Welding Society on the corrosion cracking of stainless steel. He received his bachelor's and master's degrees at Illinois Tech and his doctorate at Massachusetts Institute of Technology. An instructor at Illinois Tech from 1938 to 1941, he returned in the fall of 1946 as director of the department.

(please turn to page 58)

PHILIP DANFORTH ARMOUR — 1832-1901

Philip Armour sat listening on a Sunday long ago to a sermon by Frank W. Gunsaulus on the topic, "What I would do if I had a million dollars?" "I would establish a school to help young people who want to help themselves," the minister said. "Do you believe in those ideas you just expressed?" the rich merchant asked after the service. "I assuredly do," was the firm response.

"Would you carry them out if you had the means?" the packer questioned. "Most assuredly," said the preacher. "Very well," replied the decisive Armour, "If you will give me five years of your time, I will give you the money."

That was the beginning of Illinois Institute of Technology, which emerged from the consolidation of Lewis Institute and the institution founded by Philip Armour after hearing a sermon on a Sunday long ago.

LE CORBUSIER in his book, *When the Cathedrals Were White*, tells us that our skyscrapers are too small! Only a score of them are tall enough to please France's famous architect who thinks of buildings as machines in which to live and work. But none yet built comes up to his desire for concentration of floor space within the walls of a single structure.

These tremendous acreages under roof and behind glass would be separated by several blocks of green grass so that all rooms would receive fresh air and sunlight. Each commercial sky habitation would be reached by an elevated superhighway with intersections blocks apart so that traffic might travel above 50 miles an hour. Each would be a complete unit with motor parking, stores, restaurants, and perhaps living space for some of its thousands of productive occupants.

The great French architect has thus sketched in freehand an exciting mural of a future metropolis; but we must live with the dirt and noise of crowded streets and continuous pavements congesting and, some say, strangling Chicago and New York. If we were motivated by morals and ethics alone, we would build more skyscrapers only where they would help the transition from today's slums and slum-like workshops to tomorrow's clean, quiet, comfortable, healthful factories and habitations.

But we Americans are agreed that private initiative must not be restricted too greatly, and we have not as yet been willing to tell a land owner exactly what he can do with his land. Le Corbusier's plan might require public ownership of all the land of the city. Its fruition seems even farther in the future when we look behind Chicago's Outer Drive or move a block or two away from New York's famed Fifth Avenue.

Since our interest centers in those years bracketing 1950 when construction controls will be long past and materials will be at hand for any investor's use, we reluctantly thrust

The Empire State Building

When Will Skyscrapers Rise Again?

by LINTON E. GRINTER*

Le Corbusier's idealism aside. Hard-headed, dollar-conscious American commercialism will still determine whether the new building to be erected near State and Madison or 42nd and Broadway will be 2, 20, or 100 stories high. It is not likely that the owner will even be required by law to provide a parking place for the extra vehicles that his bright new building will bring into the traffic cage of the central business district. Aside from fire regulations and strength requirements, he will be nearly as free as a pioneer in the wilderness to build as he pleases.

If money can be borrowed freely, he will pile story on story until a height is reached beyond which the income from the next story would not amortize its cost over a reasonable period of years while returning to the owner the cost of upkeep, interest charges, and the desired profit. We must look into the probable economic conditions following 1950 to guess whether our cities will again rise to greater heights than the crowded redwood forests of the Pacific Coast or spread out interminably over poorer land in a fashion more like the mesquite country of the Southwest.

The year 1930 marks the termination of the period of skyscraper construction in the United States. Like world famous jewels, we can name nearly every skyscraper that has been planned since then. The Kohinoor Diamond and Rockefeller Center are equally renowned. 1930 also is the publication date of a book called *The Skyscraper,* written by two able economist-builders, which seems to prove that the owner of a superior building site in a central metropolitan area, seeking a high percentage return on his investment, should choose to construct a building about 60 stories in height.

Yet in the 17-year interim since this book appeared, nearly all new construction within the commercial heart of such metropolitan areas has been for "taxpayers"—buildings of a few stories, or even of one story, in height. Evidently the economic bonfire of the late twenties which burned itself out by 1930 has not yet rekindled to produce the conditions favoring skyscraper construction that these authors looked upon as normal. Let us consider some of the factors that have changed.

Central Metropolitan building sites in the late twenties were considered to have a value from 100 to 300 dollars per square foot. In the depression, site values collapsed and have been slow to revive. During a period of great construction activity, these values would no doubt reappear; but until then, we may fairly reduce the 1929 value of the site by one-half. Hence, where Clark and Kingston, who wrote *The Skyscraper,* placed a value of $200 per square foot upon a block of land 200 feet by 405 feet in size, we choose to reduce this land value of $16,200,000 to $8,100,000 as item A in the table entitled "Economic Height of a Skyscraper."

On the other hand, the cost of the building is dependent upon inflated wages and increased prices of materials which now range from 50 to 100 per cent above 1929. We will assume that the more remarkable gyrations of the present inflation cycle will quiet down and that a new stable level of construction costs will be reached at 50 per cent above the

ECONOMIC HEIGHT OF A SKYSCRAPER

Adapted to assume conditions for 1950 from estimates in "The Skyscraper", Am. Inst. of Steel Construction, 1930	8-Story Building	15-Story Building	22-Story Building	30-Story Building	37-Story Building	50-Story Building	63-Story Building	75-Story Building
INVESTMENT			(in thousands of dollars)					
A. LAND (81,000 sq. ft. @ $100 per sq. ft.	$8,100	$8,100	$8,100	$8,100	$ 8,100	$8,100	$8,100	$8,100
B. BUILDING COST (50% above 1929)	7,160	10,970	13,970	17,660	20,720	24,800	29,100	33,800
C. CARRYING CHARGES								
1. Interest during construction								
(a) Land (4% for full period)	270	323	378	432	486	540	594	648
(b) Building (4% for half period)	119	219	326	471	622	826	1,065	1,353
2. Land taxes during construction	146	175	204	233	262	292	321	350
3. Insurance during construction	3	5	8	12	21	35	65	95
TOTAL CARRYING CHARGES	538	722	916	1,148	1,391	1,693	2,045	2,446
D. GRAND TOTAL COST (A + B + C) (in thousands of dollars)	$15,798	$19,792	$22,986	$26,908	$30,211	$34,593	$39,245	$44,376
INCOME								
E. GROSS ANNUAL INCOME (70% of 1929)	1,272	1,946	2,440	2,925	3,330	3,910	4,415	4,840
F. EXPENSES								
1. Operating (50% above 1929)	467	723	888	1,085	1,220	1,413	1,585	1,820
3. Taxes (same tax rate as for 1929)	341	427	497	582	672	747	850	958
3. Depreciation (over 50 years)	143	219	280	353	414	497	582	676
TOTAL EXPENSES	951	1,369	1,665	2,020	2,306	2,657	3,017	3,454
G. NET ANNUAL INCOME (E minus F) (in thousands of dollars)	$321	$577	$775	$905	$1,024	$1,253	$1,398	$1,386
NET RETURN								
H. PERCENTAGE RETURN ON INVESTMENT (Based upon assumed conditions for 1950)	2.03%	2.92%	3.37%	3.37%	3.39%	3.63%	3.56%	3.13%
I. 1929 ESTIMATED PERCENTAGE RETURN	4.22%	6.44%	7.73%	8.50%	9.07%	9.87%	10.25%	10.06%

* *Research professor of civil engineering and mechanics, Illinois Institute of Technology.*

level of 1929. The result of applying this correction to the estimates of Clark and Kingston of the costs of eight buildings is presented in line B of the table. As shown by the block diagram, these eight buildings were obtained by successively reducing the height of a 75-story building to 63, 50, 37, 30, 22, 15 and finally 8 stories without making any other changes in the plan.

The third great element of cost, in addition to the land and the building itself, is the carrying charges. In compartment C of the table, we find a small item for insurance during construction, a major charge for taxes on the land during the one to two years of the construction period, and naturally an interest charge on the gradually increasing investment in land and building.

The tax rate per hundred dollars of land valuation is taken to be the same as for 1929, but it seems reasonable to reduce the interest rate on invested capital from 6 per cent to 4 per cent, since investment money has remained available at about 4 per cent for a decade. The sum of the value of the land, the cost of the building itself, and the unavoidable carrying charges give us the grand total cost in line D of the table for each of the eight buildings considered. This investment ranges from $15,798,000 for the 8-story building up to $44,376,000 for the 75-story building.

Now that the approximate overall investment required for each building is known, it is only necessary to estimate the probable net income from each building in order to calculate the net return on each optional investment. Net income is equal to gross income less operating expenses. Here we find a great change since 1929. Rents have decreased, and, therefore, gross income has decreased, too. While rents in 1929 were estimated from $2.42 per square foot for the least desirable office space to $18.23 per square foot for the first floor of a 75-story building, we recall that those figures were still halved in 1940. Since then, large rent increases have occurred; but to estimate the average gross rentals

The Merchandise Mart, Chicago.

over the 50-year life of a building at more than 70 per cent of the extreme 1929 rental would be dealing in economic gossamer.

Experience over many years shows that some allowance must be made for vacancies and for decreased rentals after the intangible values to the tenant of residence in a new building have disappeared. Item E in the table therefore anticipates average rentals of 70 per cent of Clark and Kingston's 1929 estimates.

Under expenses, item F, we find operation, which has been raised 50 per cent to allow for increased wages and the inflated prices of all operating supplies. As mentioned earlier, annual taxes are assumed to be based upon the same tax rate per hundred dollars of valuation as for 1929. Depreciation is simply two per cent per year, forecasting a 50-year life for the structure. The building should remain useful for more than 50 years, but it is doubtful if any investment group would be willing to wait a greater period of time for complete amortization of the initial cost of construction.

When the total expenses are deducted from the gross income, the resulting annual net income (line G) ranges from a maximum of $1,398,000 for the 63-story building down to $421,000 for the 8-story building. The net yearly income from the 75-story building is shown to be less than the net income from the 63-story building, which proves that the upper part of the structure above 63 stories is wholly uneconomic under the conditions assumed.

A comparison of the percentage returns on the total investments given in line H of the table shows that the percentage return increases gradually with height from 8 to 50 stories, remains nearly constant from 50 to 63 stories, and then decreases sharply. The conclusions of Clark and Kingston about economic height are not greatly changed if we assume that a building of eight stories or more is to be built. A wise investor will then choose a building in the range of from 50 to 60 stories where the probable return on his investment is fairly constant at about 3.5 per cent.

The question remains as to whether skyscrapers will be built at all under the conditions foreseen for the years bracketing 1950. The owner of vacant property or of an obsolescent building always may choose the alternative of erecting a low "taxpayer building", thus delaying his investment in constructing a skyscraper until the probable return appears more favorable.

If we compare the two final lines of the table, we see the great difference in predicted return on investment between 1929 and 1950. Where

(please turn to page 24)

English at Illinois Institute of Technology: *a Unique Situation*

by Alfred C. Ames *

THREE DAYS in Minneapolis last June gave me a greatly heightened awareness of the challenging and anomalous situation in which teachers and students in the department of language, literature, and philosophy at Illinois Institute of Technology find themselves. The situation is unique—more emphatically unique than I had previously realized. Some explanation of this situation may well be of interest.

Those June days in Minneapolis were the occasion of the 1947 annual convention of the American Society for Engineering Education, a large affair, with over a thousand in attendance and with many "conferences," including one in English. I can hardly explain what I learned there about I.I.T. without being to some extent personal, so I shall speak of the background subjectively and reminiscently, without apology.

The context

Like nearly all other collegiate teachers of English, as an undergraduate I was an English major in a liberal arts curriculum. My alma mater was one of many state universities that taught both "English" and "engineering English." The latter work was conducted by a separate staff, a definite enclave within the English department faculty, presided over by that rarity in university faculties, a full professor without a doctor's degree. We liberal arts freshmen rarely had engineering students in classes with us, and never in English composition. As an English major, I was hardly aware of the existence of the "engineering English" program or of its instructional staff.

After college came graduate school and a teaching assistantship for me at the University of Illinois. Illinois did not segregate its freshman engineers, but mixed all freshmen together in sections that were more or less representative cross sections. First year students in engineering, liberal arts, agriculture, fine arts, physical education, and commerce all took "rhetoric" courses in a program administered by the department of English and staffed largely by graduate students in English.

In 1941, I attended my first national convention of the Modern Language Association, the principal professional organization of collegiate teachers of English and other modern literatures. I have not missed a national convention since; and I have been consistently impressed by the tone and emphases of these gatherings. The M.L.A. is a *scholarly* organization. Its programs are largely given over to new findings or syntheses in specialized areas of literary or philological history. Its journal, *Publications of the Modern Language Association,* is famous or notorious, depending upon the viewpoint, for its solemnity (or stuffiness), substantialness (or dullness), and scientific rigor (or much ado about nothing). The "Old Guard" of the M.L.A. consists, in general, of the weightiest, best known, highest salaried professors of literature in the country. They assemble in their capacity as scholars. An observer would not learn from the official proceedings that they were teachers at all.

Illinois Tech, I was reminded in my first interview, was no ordinary engineering school as far as its English department was concerned. This I and nearly everyone else in the profession knew already, thanks to the widely known publications of some members of the staff here. A study of the catalogue (the Ph.D.'s in English from Harvard, Northwestern, Washington, Wisconsin, and Yale; the extensive list of courses) confirmed, on the customary basis of outside, uninformed judgment, the proposition that teaching English at I.I.T. was professionally honorific, rather than otherwise, and was essentially teaching English, not "engineering English."

Three years' experience on the inside, and numerous departures from and additions to the staff (none involving other technical schools) have served to support further the idea that I.I.T.'s English department has status in the main stream of university and liberal arts college English departments. Many of the courses listed in the catalogue are rarely, if ever, given, but enough materialize to enable the department to give a sound English major in the liberal studies division, and the administration unequivocally accepts university standards for its English faculty.

At the Modern Language Association conventions I can hardly turn around without seeing acquaintances from universities and present or former colleagues at Illinois Tech. At the American Society for Engineering Education convention, an almost entirely different set of English professors appeared—teachers of "engineering English" in the universities and the principal English professors of such schools as Massachusetts Institute of Technology and California

(please turn to page 28)

*Assistant professor of English, Illinois Institute of Technology.

Figure 1. The Wetherill counter-gravity casting unit as developed by Armour Research Foundation.

Controlled Pouring by the Wetherill Counter-Gravity Casting Process

by Roy D. Haworth and W. C. Wick*

THE IDEA of counter-gravity or vacuum casting is not new. In 1918, for example, a patent was issued to Simon Lake for a process involving a combination of vacuum and pressure casting. For many years the Wetherill Engineering Company of Philadelphia produced gray iron castings by a counter-gravity pressure technique in which molten metal was forced upward into the bottom of the mold cavity under pressure.

Difficulties presented by the higher temperatures required for casting steel, coupled with the dangers inherent in constraining molten metal under pressure, led to the development of the present-day counter-gravity vacuum casting technique by Armour Research Foundation under the sponsorship of the Wetherill Engineering Company and other industrial concerns. The technique in essence consists of sucking molten metal under controlled vacuum into the bottom of the mold without turbulence and without gas and dirt entrapment.

The modern Wetherill process as developed by Armour differs from Lake's process in that Lake completely exhausted the mold cavity, which was then filled with metal from the top. This vacuum, while increasing the probability of filling the molds was uncontrolled and thereby increased the natural inrush of metal and probably aggravated the formation of defects.

Undoubtedly the most important single operation in producing castings in large or small quantities is the pouring of the molten metal into the mold. Anyone familiar with casting techniques is aware of the many different types of gates used. The primary objectives of the gate should be to control metal entry into the mold at the desired filling rate and location, with a minimum amount of turbulence.

A number of advantages are to be

* *Supervisor, foundry process research, and assistant metallurgist, respectively, Armour Research Foundation of Illinois Institute of Technology.*

gained by having the metal enter the mold slowly and quietly. Gas entrapment, mold erosion, misruns, surface laps, sand and slag inclusions, to name but a few, are quite often caused by improper or uncontrolled pouring procedures. Mechanical control of pouring with scientific accuracy is now obtainable through the use of the counter-gravity method of casting. A brief description of the Wetherill Counter-Gravity Casting Machine will offer some explanation for the advantages of the process.

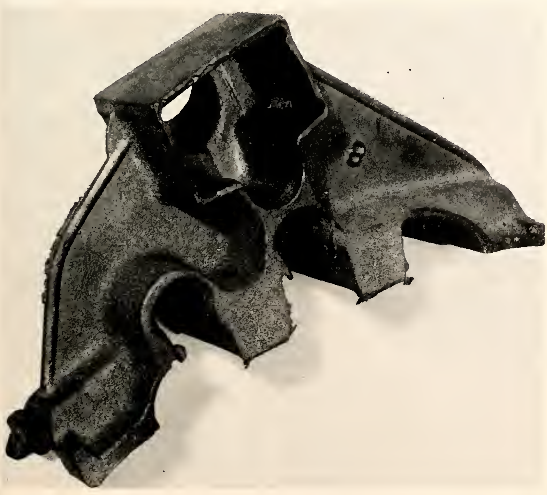
The present counter-gravity unit in operation at Armour Research Foundation in Chicago occupies a floor space of approximately 110 square feet. This area includes the casting unit or tower and the necessary vacuum pump system. The casting tower consists mainly of an angle iron structure which supports the vacuum chamber and molds. A system containing an air hoist and air-operated piston is used to raise and lower the entire mold assembly and vacuum chamber.

The machine is operated by one man at a central control panel shown to the right of the unit in Fig. 1. The equipment on the control panel consists of a series of four switches and signal lights, a control lever, an automatic timing device, and a strip chart vacuum recorder. The entire casting operation from start to finish is controlled by a multi-acting lever. A glass protection shield enables the operator to observe the entire operation from the control panel.

"The process and equipment described in this article were primarily the result of development work carried out under the direct guidance of Dr. T. C. Poulter, Associate Director, and Mr. M. H. Kalina, Assistant Chairman, Metals Research of Armour Research Foundation of Illinois Institute of Technology."

The machine ready for operation is illustrated in Fig. 1. The metal is tapped from the melting furnace into a ladle, which in turn is carried on a buggy and track under the vacuum chamber. A refractory nozzle extends below the vacuum chamber. Before the nozzle is lowered into the metal, an automatic skimmer blows slag and dirt from the surface of the metal immediately below the nozzle. The nozzle is dipped into the ladle of molten metal and the vacuum is then applied; this sucks the molten metal up into the mold.

Figure 2. Brake shoe head produced by the counter-gravity method. As quenched high-speed steel (1000 X) contains diamond-hard particles of carbides embedded in a hard (martensitic) matrix.



As the metal level drops in the ladle, the nozzle and vacuum chamber are lowered by the operator. After the molds have been filled and held for a predetermined solidification period, the vacuum is automatically broken. The entire gate and vacuum chamber containing the molds are raised from the tapping ladle and the molds are ready for the shake-out. This machine is so designed and constructed that it can be adapted to a highly-mechanized production line. For light weight castings, mold assemblies could be set up on individual buggies and rolled under the vacuum chamber at the rate of about one a minute.

Although the operation of the machine is simple, the control mechanism is quite extensive in order to insure complete and reproducible control. The vacuum system consists of a series of automatic valves which open and close the vacuum chamber from the pumps. These valves are interconnected to the interval timer which controls the total vacuum time by starting and closing a motor operated valve. Adjustments can be made on the valve mechanism to obtain a wide range of filling rates and vacuum valves.

This control makes it possible to cast a great variety of alloys, both ferrous and non-ferrous. The maximum vacuum used is determined by the height through which the metal must be raised from the ladle to fill the mold. An excess vacuum equivalent to a head of four to six inches of steel is normally maintained.

The control over pouring conditions that this process offers results in many advantages which cannot be obtained by conventional gravity-casting methods. Primarily, the process removes control over pouring from an individual basis, with the accompanying uncertainties of pouring rate and pouring temperature normally encountered in foundries, and permits establishment of precisely regulated mechanical control over this important operation.

The importance of controlled pouring is recognized by all progressive foundrymen and cannot be emphasized too strongly. For conventional

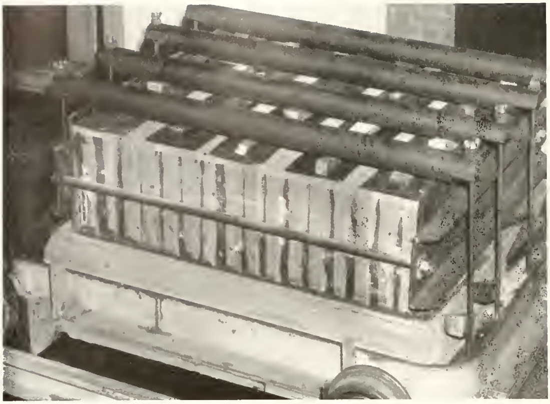


Figure 3. Assembled sand molds preparatory to casting 112 landing-gear scissors.

pouring, many elaborate gating systems are used in order to produce molds with bottom gates. In the Wetherill Counter-Gravity method all molds are bottom gated, and since the metal is sucked directly up into the mold without an intermediate down gate, a necessary evil in gravity casting, turbulence and erosion of molds are at an absolute minimum.

The filling by counter-gravity methods eliminates the variation in filling rate of the mold from bottom to top, which occurs in conventional pouring practices. By the constant lifting effect of the vacuum, the filling progresses at a uniformly smooth rate; while in gravity pouring, the mold starts to fill fast and, as the head pressure decreases, the rate of metal-rise in the mold decreases proportionately. This condition may often be the cause of misruns, i.e., failure to fill out the entire mold, particularly on castings which may be poured too slowly and on the "cold" side.

Actual pouring practice has been experimentally determined for a variety of castings, ranging in weight from approximately 1 lb. to 100 lbs. each. The filling rate is determined by the design of the casting. A casting with very thin sections, for example, can be filled more rapidly than one with heavy sections. This control over filling rate is especially important for thin section castings where mixrunning is a serious problem in conventional pouring. Many castings found difficult to fill by gravity pouring have been made with comparative ease by the counter-gravity method.

Because of the decrease in misrun defects affected by the Wetherill process, it has been possible to redesign such castings as the brake shoe head shown in Fig. 2. Sections of this casting were decreased in metal thickness from 1/4″ and 3/16″ to 1/8″ without any increased scrap loss, and service requirements were still adequate. The weight of the casting was reduced from 13 pounds to 10 pounds at the same time. The percentage of good castings produced on a series of six heats containing 24 brake heads each was 97 per cent. It has been found that less than three per cent defectives can be maintained on this type of work.

The desirable functions of the atmospheric pressure riser may be emloyed advantageously on castings requiring risers for filling by the use of counter-gravity casting technique. As the metal is drawn up into the mold cavities, the partial vacuum in the enclosed casting chamber keeps the metal in the molds for the predetermined period. If the casting design is such that heavy sections require riser feeding, the vacuum cycle will be set to hold the metal until the gate is solidified. The vacuum is then automatically released and atmospheric pressure acting on "Williams" or V-notch type riser[1] functions to feed the casting.

Another desirable feature of the counter-gravity process is the elimination of entrapped gas porosity caused by turbulence during filling. The constant vacuum has the effect of increased permeability sands because the gases are drawn out of the mold at a rapid rate, and thus the odds against gases being entrapped in the mold to cause defects are greatly diminished. The removal of air and gases ahead of the metal results in an apparent increased fluidity of the metal for a given casting temperature, particularly in light section castings. For this reason the lighter-section, lower-weight castings can be produced or lower pouring temperatures can be used, resulting in better casting surface.

In some instances, very desirable fine grain structure and reduction of coarse dendritic structures have been obtained as a result of rapid chilling of the metal in permanent or water-cooled molds. Cylinders or tubing of short lengths can be cast by the counter-gravity process without cores, and, thereby, centerline porosity, regardless of wall thickness or alloy composition, can be eliminated. When casting a cylinder, a water-cooled mold can be used to great advantage to speed solidification and production.

The mold is set up within the vacuum chamber in the regular manner and the mold cavity completely filled with molten metal. Instead of maintaining a vacuum until the gate is solidified, the vacuum is released after a predetermined period and normal atmospheric pressure enters the chamber. The center metal which has not yet solidified at that time *(please turn to page 32)*

1. This estimate is based on a 75,000 KW plant; the "California" estimate is based upon a 300,000 KW plant. It does not appear, however, that the difference between the estimates can be explained in terms of the greater economy of a larger plant. More likely, it reflects the different degrees of conservatism of the two groups of estimaters.

ATOMIC POWER

What Does It Mean To Our Peacetime Economy?

by Herbert A. Simon*

(Author's note: The material for this paper was gathered as part of a study of peacetime uses of atomic power being conducted by the Cowles Commission for Research in Economics under the direction of Professor Jacob Marschak and Dr. Sam Schurr. I am indebted to these and other colleagues on the study for their help, but the conclusions set forth here are my own.)

WE HAVE now entered Year Three of the atomic age. Two years have passed, and few of the extravagant speculations in which the commentators indulged in the weeks after Hiroshima have yet been realized. The bomb so far has not taken mankind to Armageddon—although current events offer little comfort to those who would prefer to postpone this spectacular event. On the other hand, atomic energy applied to the purposes of peace has yet neither ushered in the era of plenty nor realized the utopian's dream of a two-hour work day. Coal, oil, gas, and water still supply the energy that drives the machines.

Two years, of course, is a very short time. No one familiar with the numerous engineering problems that must be solved in reducing basic scientific discovery to practical application has had any illusion that an atomic power plant would become a reality within such a short interval. But what about the future? Although the time schedule still seems to be a matter of speculation, even among the atomic scientists, the prospects appear bright for a practical atomic power plant within five or ten years. If this goal is actually realized (and assuming—optimistically—that the bombs do not explode too soon), what effects can we expect atomic power to have upon our economy during the first generation after it has been introduced?

Prophecy on matters of this kind is a risky business. Perhaps the best the prophet can hope is that, before his predictions are proved by events to be incorrect, his prophecy will have been forgotten. He is not always so lucky. The distinguished physicist, Robert A. Millikan, writing in the pages of *Science* for September 28, 1928, was bold enough to predict:

> *"The energy available . . . through the disintegration of*

* *Professor and chairman of the department of political and social science, Illinois Institute of Technology.*

radioactive, or any other, atoms may perhaps be sufficient to keep the corner peanut and pop-corn man going, on a few street corners in our larger towns for a long time yet to come, but that is all . . . The energy supply to man in the past has been obtained wholly from the sun, and a billion years hence he will, I think, be supplying all his needs for light, and warmth, and power entirely from the sun."

Professor Millikan's billion-year estimate was quoted in 1933 by President Hoover's Committee on Recent Social Trends; and, now that the estimate has proved some 999,999,975 years too long, it still remains for all to read in the clear type of that committee's report.

One other prefatory remark is in order. The estimates contained in this paper are not based on any "confidential" information about atomic energy. The writer is not in possession of any such information. The facts that will be used as the basis for prediction are contained in two published estimates of the probable cost of producing electricity in an atomic power plant.

One of these estimates was prepared by the staff of the Manhattan Project and was published in Mr. Bernard Baruch's initial report to the United Nations. The other estimate was prepared by an unofficial group at the University of California, and it is based primarily on general engineering considerations rather than on "inside" information from the scientists actually engaged on the atomic energy project.

In what form will atomic energy be used?

Three possibilities for the use of atomic energy have been widely discussed: the generation of electric energy in an atomic power plant, the use of direct heat from an atomic pile, and the use of atomic energy in some form to propel vehicles on land, sea, or in air.

The first of these possibilities is apparently the one of most immediate practicability, and it is perhaps

not too optimistic to expect that a pilot plant will actually be constructed within five years. What problems of design are yet unsolved is a matter on which the public can only conjecture.

Direct heat from an atomic pile might have important applications in metallurgy and in the central heating of cities. It will be necessary to devise materials, for use in the structure of the pile, that will not disintegrate under a combination of high temperature and radioactive bombardment, and to devise a method for transferring heat without transferring harmful radioactivity.

The possibility of powering automobiles, trains, airplanes, or boats with atomic energy appears somewhat remote because of the shielding problem. Until nuclear radiation can be blocked by something lighter than a four-foot concrete wall, we will have to rely on more traditional fuels for our transportation.

Since electric energy appears to be the most likely atomic product in the near future, we will be primarily concerned in our discussion with this particular application.

Atomic energy is not free energy

Some of the more extravagant predictions for the atomic era have been based upon the misconception that atomically-produced electricity will be virtually free electricity. This idea is entirely false.

Any engineer knows that the cost of fuel is only a very small part of the cost of electricity. We are already getting a substantial part of our electricity from "free" fuel—waterpower. But before falling water can be transformed into electricity, dams must be built, generating stations constructed, transmission lines erected. The interest on the investment in these structures, their depreciation and obsolescence, and their maintenance and operating costs must all be charged against the electric energy that is generated. Even in a coal generating plant several hundred miles from coal mines, the fuel cost will amount to only about 2 mills per kilowatt hour generated out of a total generating cost of 4½ to six mills.

In estimating the cost of atomic energy, the fuel cost can be neglected —regardless of the price of uranium —since once the pile is in operation, it will manufacture its own fuel. Hence, the important question is: what will be the capital investment and operating cost of an atomic plant in comparison with coal and hydroelectric plants?

According to the "official" estimate presented by Baruch, the capital investment in an atomic generating plant will be about $325 per kilowatt generating capacity.[1] The California group arrived at the much more optimistic investment figure of $130 per KW. Annual charges—interest, depreciation, and obsolescence —of not less than 10 per cent must be assessed against this investment. If we assume a load factor of 50 per cent, each kilowatt of capacity will generate 4,380 KWH of electricity per year. With an annual charge of $13 to $33 per KW, we get a generating cost—for fixed charges alone—of 3 to 7.5 mills per KWH. To this must be added operating and maintenance charges of not less than 1 or 1.5 mills per KWH.

Even if the more optimistic investment figure is the correct one, we see that our electricity will cost 4 to 4.5 mills per KWH at the generating station; while if the more conservative estimate is correct, it will cost 8.5 to 9 mills. Four mills is about the cost of electricity at our most economical hydro stations, and that is not much below the cost of electric-

(please turn to page 34)

SPECIAL STEELS FOR SPECIAL ABILITIES

by OTTO ZMESKAL*

MAN has known steel for thousands of years, but alloy steels have been known for scarcely a century. The steel used by man for so long a period is what is known as simple carbon steel. Carbon is the only essential alloying element. The effect of this simple addition is so potent that through its control man has been able to fashion every article and tool he has needed for a relatively simple existence. The art had been known since antiquity, but the science came very slowly afterward. The British Museum has a piece of hardened steel found in the pyramids, but Sorby first applied the microscope to study of metals in 1864.

Man's material progress prior to the nineteenth century was as a crawl compared to the pace of his advance since then. The industrial revolution brought the age of specialization; specialties required enlargements of abilities; special abilities required special steels. "Tubal Cain his spearhead wrought from ore he smelted with the thorn and cactus tree," but armor piercing projectiles must be made from alloy steel.

The maximum hardness of a steel is determined by its carbon content. The soft malleable articles are made of very low carbon steels; and, as the hardness requirements are raised, the carbon is increased. Additional hardness and strength are obtainable in the higher carbon steels by heat treatment.

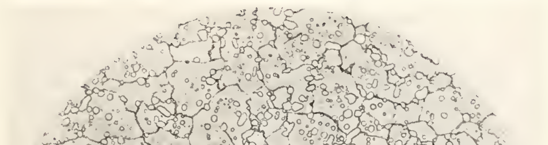
Even today, for many purposes simple carbon steels are entirely satisfactory. Where hardness, strength, resistance to impact, and ductility, all in a fairly narrow temperature range around room temperature, are required, they are the most economical steels for the purpose. The machines of our highly complex civilization, however, have many components that undergo unusual conditions. Where strength, hardness, resistance to impact, and ductility are required either at high temperatures or at low temperatures, simple carbon steels are not satisfactory. Where the corrosion resistance imparted by painting, plating, or dipping is not enough, simple carbon steels can not be used. Where large parts must be hardened throughout the section, simple carbon steels will not do.

Although the many demands of our highly mechanized existence require many special steels, all of these steels may be classed into four basic groups:

(1) **Engineering alloy steels**
(2) **Tool steels**
(3) **Stainless steels**
(4) **Heat resisting steels**

The engineering alloy steels comprise the group catalogued under the S. A. E. four-number system; i. e., they are low in alloy content and simple in composition. The total alloy content is under 5 per cent, and the number of alloy elements rarely exceeds 3 per cent (other than the manganese and silicon present in

* *Professor and director of the department of metallurgical engineering, Illinois Institute of Technology.*



High-speed steel must be hardened from a temperature close to its melting point, but when this temperature is silghtly exceeded, the carbides migrate to the grain boundaries and fuse. Upon solidification they assume this skeleton-like shape.

When tempered, the martensitic matrix ejects myriads of tiny carbides and etches very dark. The corrosion resistant large carbides stand out in relief.

both alloy and simple carbon steels for reducing the embrittling effect of sulfur and oxygen). Their purpose is primarily to increase the depth of hardening.

When a steel is hardened through in the quench (that is, no soft core is produced) its mechanical properties on subsequent tempering are much better than the like properties of a steel incompletely hardened through on the quench. Simple carbon steels have such high reaction rates of transformation to a soft structure during the intended hardening that only a relatively thin skin can be formed in the completely hardened condition. The function of the alloying elements in the engineering alloy steels is to slow down the softening reaction and thus permit deeper hardening for a given cooling rate.

Through methods originally devised by Marcus Grossmann, director of research of the Carnegie-Illinois Steel Corporation, it is possible to calculate the composition of steel that should be ordered for a job, knowing the size of section and the nature of the hardening treatment to be followed. This work, and it has been verified fully by experiment, has shown that small amounts of several elements are of greater influence on promoting deep hardening than a considerable amount of a single element. The product of war development, the N. E. steels and their counterpart, the S. A. E. eight-thousand series, are triple alloy steels, containing nickel chromium and molybdenum. The element giving the strongest hardenability effect, as now known, is manganese; and it is used to fortify the previously mentioned three.

Aside from increased depth of hardening, certain alloy additions, as vanadium, promote fine grain, which markedly increases the shock resistance of the hardened condition.

Simple carbon steels become very brittle at low temperatures (the cause of many welded-ship failures in the North Atlantic during the past war). Certain alloy additions, such as molybdenum, markedly lower the temperature at which this brittleness occurs.

Salesmanship principally established low alloy steels in the early part of the present century and oversold certain compositions. War-time research, however, has put the purchase of these steels on a scientific basis.

The first alloy tool steel was made by Robert Mushet in 1868, and for 20 years this was the only alloy tool steel made. Now there are many different compositions available, fitting the needs of our complex mechanization.

What was the power unleashed in the early part of the nineteenth century that started man on this onrush of material progress? The tools made of simple carbon steel suited his purposes for many thousands of years, but now he was to need constantly improving ones. Why was it that this material progress became so greatly accelerated and why is it yet increasing in its acceleration? Appropriately, Samuel F. B. Morse, in the year 1844, sent these words in the first telegraph message: "What Hath God Wrought?"

Carbon tool steels could not keep up with the pace of increasing cutting speeds and feeds; and, in fact, our best alloy tool steels will not be able to take the pace of the near future. Most of the new designs on machine tools are based on the use of cemented carbides, in which iron exists only as a trace.

What did carbon tool steels lack? In the first place, the factors that make a tool steel are: first, its hardness; second, its ability to keep that hardness to a good measure at the elevated temperatures experienced in heavy or in high-speed cutting. Increasing the carbon to 0.80 per cent and above gives the requisite hardness; but there is no resistance on the part of carbon steels to softening by heat. The carbon atoms move from the positions in the iron atom lattice that is the hard structure to the positions of the softer structures under the increase in energy resulting from heat. If the softening temperature is to be raised, other kinds of atoms are required to hinder

this movement of the carbon atoms.

The most effective element is tungsten, and the least effective is iron itself. In general, the more complex the constitution, that is, the more different kinds of refractory atoms in the lattice structure, with more difficulty does the carbon atom move; and the tools made from such steels cut at higher temperatures. The highly unsettled conditions in China have made the price and supply of tungsten extremely variable.

Fortunately, we do not have to depend on tungsten for this property. Molybdenum, of which we produce 90 per cent of the world's supply (and most of that from one mountain in Colorado) is as effective as tungsten. Also found in modern high-speed tool steels are chromium, vanadium, and cobalt. Although the cutting properties of high-speed cutting steels are somewhat proportional to their alloy content, certain compositions have been found to give optimum results. Giving the figures in percentages, either 18 tungsten or 9 molybdenum, 4 chromium, 2 vanadium, and 10 cobalt is the most satisfactory tool material of the iron base alloys.

This steel, and steels similar in composition, cut at a dull red heat. By eliminating the iron and increasing the chromium, tungsten, cobalt, and carbon, a material is obtained (non-workable tools can be cast to shape) that will cut at a bright red heat.

Basically, the cutting tool should consist of hard diamond-like particles supported in a hard matrix that will stay hard at elevated temperatures. The hardest particles are the carbides, borides, and nitrides of tungsten, molybdenum, titanium, and vanadium. The best matrix is none at all, but a tool material cannot be made of hard particles alone; they must be bonded. The most satisfactory binder is cobalt. When the hard particles are present to about 90 per cent of the structure, we have the tool material for greatest production, the cemented carbide.

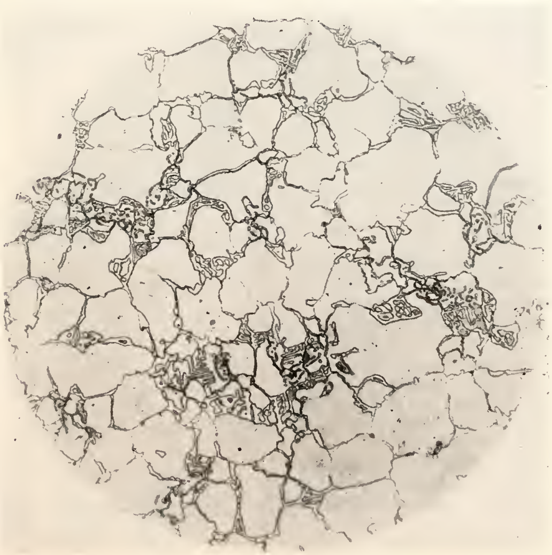
The die steels are also a part of the tool steel classification. The basic composition for a good cutting steel is also satisfactory for a good die steel. For cold die work, such as in shearing, high chromium steels are mainly used, principally because of their lower cost. For hot die work, such as in extrusion, the composition depends upon the temperature, the amount of tungsten and chromium increasing with the service requirements. Because extreme hardness is not needed in the die steels for hot work, the carbon is lowered to one-third of its value in cutting steels; this also increases the ability to withstand thermal shock.

The stainless steels have also contributed greatly to man's comfort and well-being. The immense chemical and food industries could not have developed to their present stature, supplying good things for all men to enjoy, had not stainless steels been available in quantity.

The principal element of steel—iron—is very readily attacked by many substances. When chromium is dissolved in the iron, the resulting alloy has increased resistance to attack; when the ratio of iron atoms to chromium atoms in solution is under 11 to 1, the resulting alloy steel is immune to atmospheric attack, to oxidizing acids like nitric, and to many food acids. As the amount of chromium increases so does the corrosion resistance.

For the milder corrosive conditions, such as encountered in the steam turbine, steel containing 12 per cent chromium in solution is entirely satisfactory. Notice the emphasis on chromium in solution; for, the chromium out of solution might as well not be there for all the good it does in enhancing the steel's corrosion resistance. How can the chromium get out of solution? Carbon is the answer. Chromium and carbon are such good friends that they get together instantly when in sight of each other. The only way to break up this union is to use very high temperatures; and, if the carbon is high enough, the steel will melt before all the chromium leaves the car-

(please turn to page 42)



As Quenched High Speed Steel (1000 X) contains diamond-hard particles of carbides embedded in a hard (martensitic) matrix.

Excerpts from

Institute Of Gas Technology

Annual Report 1947-48

by ELMORE S. PETTYJOHN*

THE Institute of Gas Technology completed its sixth year of operation on August 31. The year's developments included several that were significant and auspicious. Among these was a substantial increase in the Institute's participation in the gas production research program of the American Gas Association. Most satisfactory contractual relations, together with a more complete recognition of the needs of the Institute, have been developed with the association.

During the last 12 months, the Institute has moved further in the direction of accomplishing the purposes for which it was established. While definite progress has been made, the Institute has continued to be handicapped by shortages in personnel and equipment, an aftermath of the war. The improvement in the financial position is shown in the accompanying charts.

The first, presenting the sources of gross income, shows the effect of the shifting of the research program into the gas field largely as a result of the splendid three-year program sponsored by the American Gas Association post-war planning committee and developed by the special committee on gas industry research and promotional plan.

The second, presenting the increase in assets, shows the rapid improvement in current assets with the termination of the war and the accompanying stabilization of the Institute's research, the latter again largely effected through the research program of the American Gas Association.

Improvement in financial position is a direct result of the continued support by members of the gas industry. The associate members and contributors who have supported and are still supporting the Institute are listed in Table I. Membership dues from 60 utility companies, appliance manufacturers, and ancillary companies totaled approximately $67,000 during the past year. In this same period, general contributions from nine companies amounted to more than $5,400 and special contributions from six companies totaled $53,500. Membership dues and contributions amounted to more than $125,000.

Education

The educational program, which was nominally suspended in February 1944 because of a change in selective service regulations, was re-established with the fall semester of 1946. Former fellows, who had withdrawn to enter the armed services or governmental activities, were contacted to determine their desire to participate in the program upon its re-activation. From the replies received, eight former fellows and two new candidates were enrolled. The first postwar class consisted of one doctoral candidate, one refresher, and seven masters candidates. At the end of the first semester, the refresher candidate, Thomas L. Pelican, completed his course work and was employed as a gas engineer by the Natural Gas Pipe Line Company of America in Chicago.

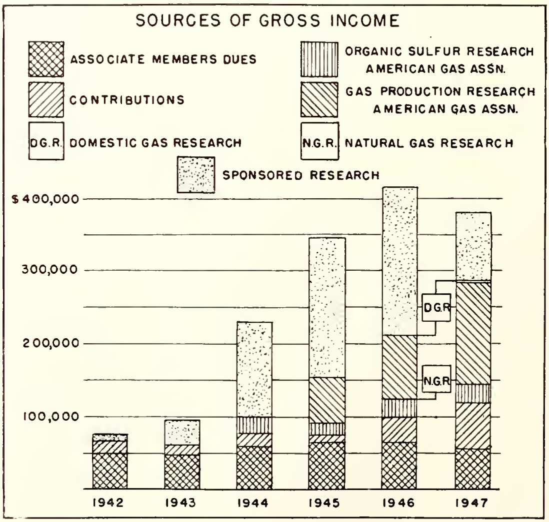


Chart I

Fiscal Periods *1941-42 June 1-Aug. 31*
1942-47 Sept. 1-Aug. 31

*Director of the Institute of Gas Technology.

TABLE I

Roster of Associate Members

August 31, 1947

Amarillo Gas Co.
American Stove Co.
Atlanta Gas Light Co.
Autogas Co.
Bastian-Morley Co.
Blaw-Knox Co.
Boston Consolidated Gas Co.
Bridgeport Gas Light Co.
Brooklyn Union Gas Co.
Bryant Heater Co.
Cambridge Gas Light Co.
Central Hudson Gas and Electric Corp
Cincinnati Gas and Electric Corp.
Coast Counties Gas and Electric Co.
Colorado Interstate Gas Co.
Columbian Carbon Co.
Columbia Engineering Co.
Connelly Iron and Sponge Governor Co.
Consolidated Gas Electric Light and Power Co.
Continental Carbon Co.
Derby Gas and Electric Co.
Dresser Industries
E. I. du Pont de Nemours and Co.
East Ohio Gas Co.
Globe-American Corp.
Hartford Gas Co.
Hope Natural Gas Co.
Hope Producing Co.
Houston Natural Gas Co.
Inland Steel Co.
Interstate Natural Gas Co.
Lone Star Gas Co.
Michigan Consolidated Gas Co.
Minneapolis Gas Light Co.
Mississippi River Fuel Corp.
New Bedford Gas and Edison Light Co.
New York State Natural Gas Corp.
Ohio Gas Light and Coke Co.
Pacific Lighting Corp.
Peoples Natural Gas Co.
Pittsburgh Consolidation Coal Co.
Portland Gas and Coke Co.
Rochester Gas and Electric Co.
Rockland Gas Co.
Rockwell Manufacturing Co.
Geo. D. Roper Co.
Seattle Gas Co.
Servel, Inc.
Southern California Gas Co.
Southern Counties Gas Co.
Standard Gas Equipment Corp.
Surface Combustion Corp.
Titan Valve and Manufacturing Co.
United Cities Utilities Co.
United Gas Pipe Line Co.
Warren Petroleum Corp.
Washington Gas Light Co.
West Texas Gas Co.
Wisconsin Public Service Corp.
Worcester Gas Light Co.

Roster of Contributors

Sept. 1, 1946—Aug. 31, 1947

Arlington Gas Light Co.
Consolidated Natural Gas Systems
Educational Foundation
Haverhill Gas Light Co.
Laclede Gas Light Co.
Lawrence Gas and Electric Co.
Frank H. Lerch, Jr.
Lynn Gas and Electric Co.
Malden and Melrose Gas Light Co.
Montana-Dakota Utilities Co.
Peoples Gas Light & Coke Co.
Pittsburgh Consolidation Coal Co.
Rochester Gas and Electric Co.
Williams Brothers Co.
Worcester County and Electric Co.

The present roster of students and the degrees granted by Illinois Institute of Technology to students who completed their work at the Institute of Gas Technology are shown in Tables II and III. Progress in student enrollment is shown in the accompanying chart. An examination of this chart will show the impact of the war upon the educational program, an impact which almost destroyed its effectiveness. The reestablishment of the educational program was made possible largely by contributions by companies and individuals for fellowships and educational purposes. Such contributions have been set aside in a special educational reserve, and the amounts withdrawn for fellowship stipends and institutional fees have been transferred from this fund to income as required.

Dr. Joseph D. Parent is in active charge of the educational program. He is working with the graduate committee of Illinois Institute of Technology to coordinate the instruction so that the requirements for the degrees of master of science and doctor of philosophy in gas technology may be met. The curriculum has been revised to provide a more precise presentation of the material required by the by-laws of the Institute. More information is presented in the 1947-48 catalog.

The instruction in utilization has been enlarged through the use of outside lecturers and afternoon classes in the service school and appliance testing laboratory of the Peoples Gas Light and Coke Company.

The former practice of having semi-monthly seminars addressed by recognized leaders in various phases of the Gas Industry and by members of the research staff has been reestablished. Last year students and staff had the very fortunate opportunity of listening to the following:

Harry E. Bates, Powell Cooper, Fenton Finn, Mark Fred, Edwin L. Hall, Marvin F. Johnson, and Frank H. Lerch, Jr.

Library

Every effort is being made to provide a library that is unsurpassed in

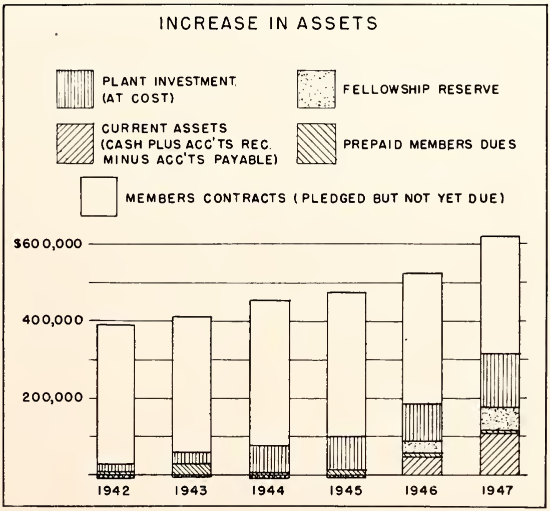


Chart II

Fiscal Periods 1941-42 June 1-Aug. 31
1942-47 Sept. 1-Aug. 31

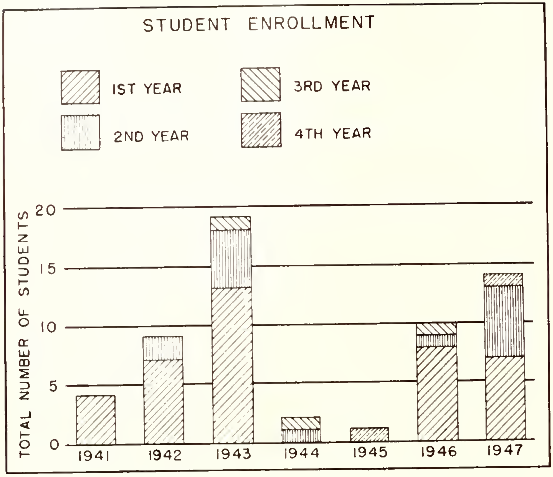


Chart III *Program Terminated 2-26-44 by Selective Service* *Re-established 9-23-47*

the field of Gas Technology and related subjects. Much has already been achieved in this direction. Practically all important manufacturer's literature, patents, and American and foreign periodicals and books which are pertinent to the Gas Industry are to be found here. Further, subject files are being built up for topics of special interest to members of the Gas Industry. Some foreign publications which are extremely difficult to obtain are available on micro-film. A Recordak micro-film reader is on hand for use with this material.

In addition to collecting scientific publications pertinent to the Gas Industry for the use of the students and technical staff of the Institute and representatives of member companies, the Institute offers certain services to its member companies to fulfill its objective of collecting and disseminating information.

One of the most important services rendered by the Library is the preparation of the monthly *Gas Abstracts*. New books, patents, and periodicals are reviewed, and those containing information of importance to the Industry are abstracted by the members of the research staff. *Gas Abstracts* is sent free to member companies; it may be obtained by others for a nominal fee. An annual index, arranged both by author and subject, is published. Articles in the literature reviewed are micro-filmed upon request. Also, bibliographies, translations and literature surveys are prepared upon request. If the survey involves an analysis and critical evaluation of data, equipment, or methods, a member of the research staff is assigned to the task. Thus, a survey and critical evaluation of all data relating to the hydrates of the hydrocarbons, together with an analysis of the patents from the engineering point of view, has recently been completed for the National Gas Department of the American Gas Association by a member of the research staff.

Facilities

Space occupied by the Institute has been limited to the area available in 1946, because of the large influx of students at Illinois Tech. This limitation has made it necessary to utilize all of the ground area to its maximum loading. New equipment on order will result in even further crowding. Limited space has required the disassembly of research equipment as soon as a project is completed and has necessitated the re-erection of new facilities on the old site. In some instances, this has proven to be a wasteful procedure but one which can be avoided only by increasing the floor area available to the Institute. These increasing needs again have raised the desirability of obtaining a new and modern research building for the Institute. Some preliminary sketches of such a building have been prepared and cost estimates have been made.

The American Gas Association has undertaken to solicit its membership for contributions to a building fund for the Gas Institute. This campaign is in progress at present and the very early returns indicate a generous response. When the necessary funds are secured, erection of a new building on the south side of 34th street can be started. To broaden the scope of the Institute's work, it is absolutely essential that the following laboratories be equipped and manned: High Pressure, Low Temperature, Gas Standards, Spectophotometry, Physical Measurements, Physical Testing of Coal and Coke, and Utilization.

The Institute's present facilities do not provide sufficient space to accommodate more than a small fraction of the equipment necessary for these laboratories. This lack of space and equipment for research and development and the additional lack of adequate housing for the student program are the major reasons for emphasizing the necessity of a new building at this time.

Research Program

During the current fiscal year, the research activities of the Institute have been carried forward in three major groupings: (a) American Gas Association research, (b) sponsored research and tests, and (c) basic research.

The work for the Gas Production Research Committee has been concentrated largely upon the solution of the peak load problem. This problem has been attacked at three points.

(please turn to page 46)

German Publications

Since the End of the War

by F. K. RICHTER*

AN EXACT account of what has been going on within the realm of German letters since the end of the conflict can be given only if we limit our subject. For this reason all literature of German refugees is omitted here, since it is easily available. Scholarly essays and theses are also outside of the field of our investigation.

The most obvious fact about new books from Switzerland, Germany and Austria is the considerable number of new editions and selections of already known and established literature and of modern writers. There is *Tristan*[1] very pleasantly retold in prose, and there are fine selections of Silesius, Goethe, Hölderlin, Claudius, and Stifter, and of moderns such as Trakl, Heym, Morgenstern, and Hesse. Many of these works were published in the series *Poetry of Consolation, Lasting Letters of All Times*[2]. The title may indicate that, in these times of national disaster, this particular literature seems to give the most comfort and consolation to the German people. The authors themselves appear to be especially akin to today's German through their own troubled lives. (Silesius' homeland was devastated by wars, and Hölderlin, Stifter, Trakl, and Heym lived tragically or became insane or committed suicide.)

A second category of books deals with the events of recent years. These can be divided into several groups. There are, first, a considerable number of journalistic accounts, written close to the occurrence at the time of the event or shortly afterwards; these do not go much beyond mere fact-recording. The diaries of Ambassador von Hassell[3] belong to this group and seem to be particularly informative and moving. Beginning at the Munich Conference, these diaries continue until shortly before July 20, 1944, the day of the "putsch" against Hitler, which Hassell helped prepare. Often the memos were

jotted down on trips, quite sketchily and using fictitious names for the major figures.

Indignation and shame flow out of the work about things that were done in the name of his nation, and it is easy to follow the diplomat as he endeavored to prevent the war or to finish it as soon as possible by informing representatives of foreign powers about the final Nazi plans. This serious matter is interwoven with delightful anecdotes which Hassell actually experienced on his various trips through the Reich—anecdotes which may indicate to some extent the true feelings of the various classes of the population.

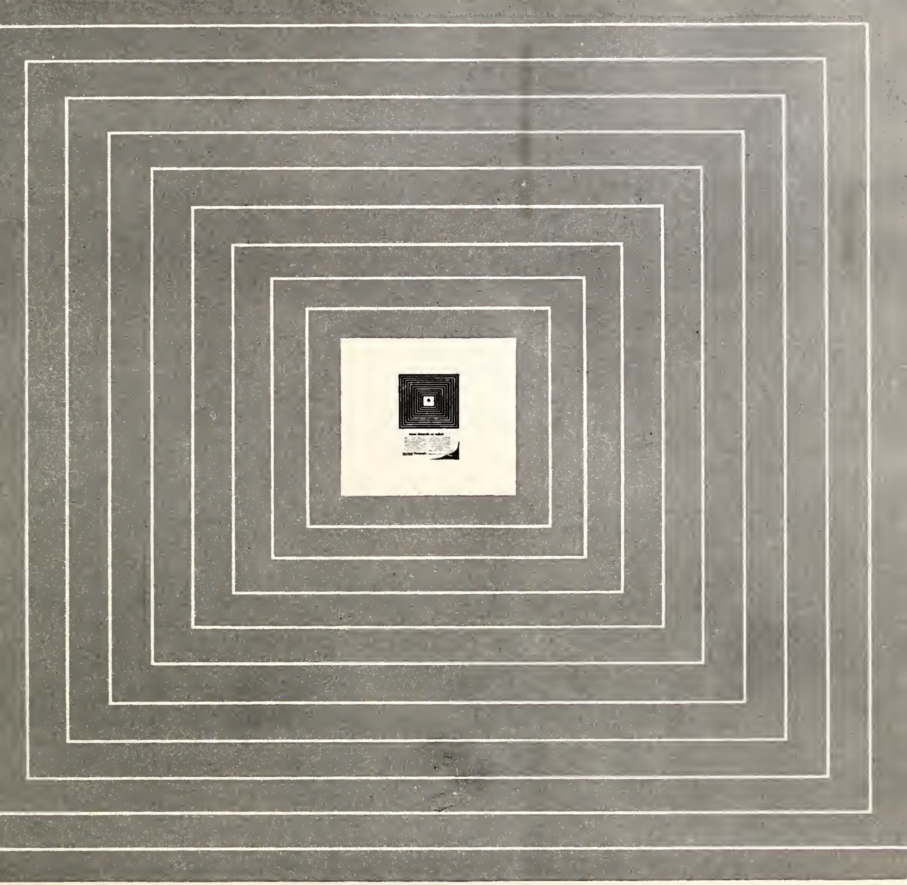
The book *Officers Against Hitler* by Fabian von Schlabrendorff[4] also contains much informative material. It is not so detailed and variegated, however, as that of Hassel. Schlabrendorff concentrates largely on the preparations for the coup of July 20. In addition to this information—information which seems to make us modify somewhat our hostile attitude toward the leading German Army officials—I find the description of Hitler particularly good: a man, equipped with an almost diabolic foresight, sensing attacks upon his life, and foreseeing national disaster. Those books by Hassel and Schlabrendorff render service to present-day Germany by indicating that there was resistance against Hitler in diplomatic as well as in army circles.

A third book of information comes to us from a poet, Ernst Wiechert. Unlike the attitudes of the officer or the diplomat, the poet reports only about himself, his fate, and his impressions. He calls his work, *The Forest of The Dead*[5], a report. Although Wiechert intends it to be nothing more than a report, it nevertheless projects itself into the next group of recent German publications, which tries to interpret events and seeks meaning behind them. Johannes, which is Wiechert's name for himself in this book, overcomes the misery of his months in Buchenwald—and, in fact, his whole period of history—through his passive attitude of accepting suffering.

To this attitude he had come after many years of spiritual struggle. In the acceptance of suffering he sees the only possibility of lightening his fate; he believes that in so doing he forces God to grant relief. When Wiechert left Buchenwald, someone in the barracks remarked, "When he came here, his face looked like a rock, and as he leaves, it looks the same."

(please turn to page 50)

* *Associate professor of modern languages, department of language, literature, and philosophy, Illinois Institute of Technology.*



Because photography can condense . . .

Tiny as it is, that little rectangle "stage center" *is* this ad . . . condensed by microfilming's magic. Condensed yet all there—ready to be brought back to original size. Photography can reduce—tremendously—without losing a detail.

As a business or professional man, you can utilize photography's reducing ability in important ways.

You can utilize it to save space . . . to speed reference. With Recordak microfilming, you can "debulk" files 98% . . . keep the film records at hand for quick viewing, full-size, in a Recordak Reader.

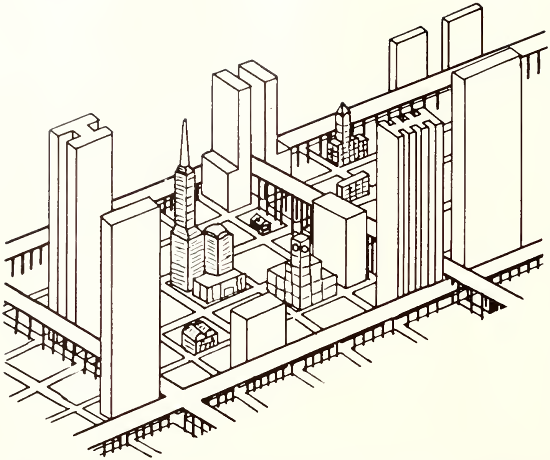
You can utilize it to make sales presentations more complete, more resultful. With motion pictures, you can "pack" a plow, a plant, a whole process into a small can of film . . . travel it where you will . . . show it off "large as life" and much more dramatically.

Only a suggestion . . . this . . . of what photography can do because it can condense. For a better picture of the applicational possibilities that stem from this and other unique characteristics of photography, write for "Functional Photography."

Eastman Kodak Co., Rochester 4, N. Y.

Functional Photography is advancing business and industrial technics.

Kodak



Master skyscrapers would rise near super-highway outlets. The interior buildings would then grow obsolete and would not be replaced.

Skyscrapers . . .

(continued from page 8)

the most favorable annual return anticipated in 1929 was 10.25 per cent on a $39,142,000 investment in a 63-story structure, the largest return to be expected on a 1950 building is 3.61 per cent for the 50-story structure costing $34,593,000.

It becomes clear then that the rush to build skyscrapers in the late twenties was motivated by the expectation of a nearly usurious return. The collapse of that investment bubble was so complete that most of the buildings had to be placed in receivership. Now, after having found the probable return to be 3.5 per cent on the investment in a building to be opened in 1950, we need not ask why investment groups are apathetic toward skyscraper construction.

The possibility of a depression, during which several annual deficits might develop, will probably keep investors away from the skyscraper market until an increase in rentals or a decrease in construction and operation costs brings the predicted return up to at least 5 per cent. At that rate of return, the construction of a skyscraper might compare favorably as an investment possibility with blue-chip stocks or industrial bonds. Large-scale housing and skyscraper construction have to compete for the investor's dollar with business and industrial investments because money in a free economy continually seeks the greatest probable return.

We have concluded that the calculated prospect of return on the investor's dollar does not now forecast the raising of great skyscrapers. Le Corbusier explains that the erection of additional skyscrapers placed at random in the constricted kernel of a metropolitan area would choke its already swarming streets beyond relief.

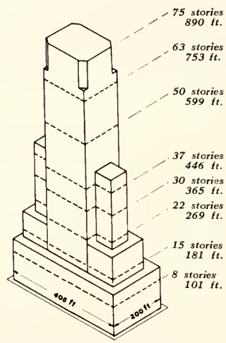
His shocking observation that we have as yet developed only one entirely successful means of transportation—the vertical elevator—places emphasis upon our greatest metropolitan problem. Perhaps by a kindly economic fate we shall be saved from desperately damaging our own future. It will be fortunate if we build few skyscrapers until engineers have reduced the traffic glut of supersaturated streets.

American industrial civilization is dependent upon the automobile, but the building matrix of American cities had solidified before 1900, when traffic consisted of vehicles moving four or five miles per hour and the metropolitan populations encompassed less than one-half of their present millions. Depressed or elevated superhighways will eventually speed traffic through or over residential areas, but no engineeding plan has yet been detailed that will move traffic smartly into and through a central business district where the motor deluge equals that of the Chicago Loop.

Le Corbusier's replacement of present city blocks by a greater grid system of quarter- or half-mile squares serviced only by elevated superhighways neglects the fact that present buildings cannot be abandoned; nor can the first one of his master skyscrapers be built until a superhighway system is devised to service it.

Elevated superhighways such as the Congress Street development in Chicago are under way. When an elevated superhighway is completed, it will provide exceptional traffic service to those buildings near its traffic outlets. New skyscrapers may then become good investments when placed where the solution of the traffic problem raises the rental value.

To attract a high rental, the in-



Approximate outlines of eight buildings studied in "The Skyscraper" and re-estimated for 1950 costs.

vestor may decide that convenient indoor parking will be essential; and he may enlarge the design of the structure to provide for automobiles. If not, he should be helped to reach this decision by a proper city ordinance.

As other superhighways are built, Le Corbusier's greater grid system may develop naturally with the greatest commercial sky habitations located at the intersections of such superhighways, where traffic can readily reach the building from any direction. In the end, the lower grid of present streets within the business district may gradually become almost the exclusive property of street railways or busses and slow moving commercial vehicles.

When this stage approaches, it seems clear that buildings not connected to the elevated superhighway grid will depreciate in value, and when obsolete they may not be rebuilt. At reasonable cost, the city might then purchase such internal properties and begin the development of the ideal green city.

The Field Building, Chicago.

Private enterprise works less spectacularly than planned economies, but it is continuously at work. One of its tests is approaching, for we can neither long forget nor eventually fail to find an open way around the traffic quagmire which has become the gravest physical problem of metropolitan life.

Augustus rebuilt Rome and the Napoleons Paris by imperial dictate. If capitalism is to rebuild Chicago and New York without governmental dictum, it must become sensitized not to economic law alone but also to the desires of society.

NATIONAL ELECTRONIC

November 3-5, Edgewater Beach Hotel, Chicag

Monday, November 3

9:00 A. M. Registration
Edgewater Beach Hotel

10:15 A. M. General Meeting
Keynote Address by President George D. Stoddard, University of Illinois
"Electronics Comes of Age" by L. V. Berkner, Joint Research and Development Board

12:15 P. M. Luncheon Meeting
Speaker: W. Evans, Vice President of Westinghouse Electric Corp.

2:00 P. M. Technical Sessions

1. NOISE SUPPRESSION, DISTORTION
   - (a) "Dynamic Noise Suppressor" by H. H. Scott, Technology Instrument Corp.
   - (b) "Intermodulation Method of Distortion Measurement" by W. J. Warren, Univ. of Santa Clara and Hewlett-Packard Co., and W. R. Hewlett, Hewlett-Packard Co.
   - (c) "S/N Ratio in AM Receivers" by E. C. Fubini and D. C. Johnson, Airborne Instruments Lab., Inc.
   - (d) "Corona Discharge at High Altitude and Low Temperature" by H. J. Dana, State College of Washington
2. ELECTRONIC INSTRUMENTATION I
   Chairman: M. F. Behar, Editor of Instruments
   - (a) "Self Balancing Thermistor Bridge" by C. C. Bath and H. Goldberg, Bendix Radio Corp.
   - (b) "Variable Ratio Inductance Bridges and Networks" by Paul Glass and Sylvia May Dushkes, Askania Regulator Co.
   - (c) "A Miniature Gastro-manometer for Electrical Recording" by H. C. Roberts, University of Illinois
   - (d) "Short-Time Oscillography" by Jean V. Lebacqz, Johns Hopkins University
   - (e) "Luminescent Screens for Cathode-Ray Oscillography" by Carl Feldt, A. B. DuMont Labs., Inc.
3. COAXIAL ELEMENTS AND MICROWAVES
   - (a) "Bead Supported Coaxial Attenuator (4000 to 10,000 mc.)" by J. W. E. Griemsmann and H. J. Carlin, Microwave Research Institute, Polytechnic Institute of Brooklyn
   - (b) "Wave Propagation in Beaded Lines" by R. E. Beam, Northwestern University
   - (c) "Coaxial Elements and Connectors" by W. R. Thurston, General Radio Co.
   - (d) "Broadband Matching of Impedances" by R. M. Fano, Massachusetts Institute of Technology
   - (e) "Broadband Bolometer Type UHF Power Meters' by M. J. DiToro, Polytechnic Institute of Brooklyn
4. OPERATION OF ELECTRONIC RESEARCH
   Chairman: J. E. Hobson, Armour Research Foundation
   - (a) "Organization and Management of Electronic Research" by R. M. Bowie, Sylvania Electric Co.
   - (b) "Electronic Research in the University" by L. T. DeVore, University of Illinois
   - (c) "Electronic Research in the Research Institute" by G. E. Ziegler, Midwest Research Institute
   - (d) "Electronic Research in the Government Service" by Archibald S. Brown, Wright Field

7:00 P. M. Banquet—Marine Dining Room
Edgewater Beach Floor Show and Dancing. (Ladies cordially invited, informal)

Tuesday, November 4

9:00 A. M. Technical Sessions

5. MICROWAVES
   - (a) "Higher Mode Techniques for Wave Guides" by M. W. Goodhue, Polytechnic Research and Development Co.
   - (b) "Multiplex Transmission Through Wave Guides Using Higher Order Modes" by R. R. Buss, W. A. Hughes, H. D. Ross and A. B. Bronwell, Northwestern University
   - (c) "Microwave Spectroscopy" by D. K. Coles and W. E. Good, Westinghouse Electric Corp.
   - (d) "Noise Reduction in Radar and Communications" by S. Goldman, Massachusetts Institute of Technology
6. Joint session of National Electronics Conference and AIEE, program arranged by the AIEE
7. COMPUTERS
   - (a) "Electronic Computers" by J. W. Mauckly and J. P. Eckert, Jr., Electronic Control Co.
   - (b) "Storage of Numbers on Magnetic Tape" by J. M. Coombs, Engineering Research Associates
   - (c) "Computers for Aeronautical Navigation" by Hugo Schuck, Minneapolis-Honeywell Co.
8. ELECTRONIC CIRCUIT ANALYSIS I
   - (a) "Cathode Tap, Cathode Follower Amplifiers" by B. B. Underhill, Penn State College
   - (b) "Low Power Frequency Multipliers" by R. J. Schwarz, Columbia University
   - (c) "Series Mode Quartz Crystal Oscillator Circuit" by H. Goldberg and E. L. Crosby, Jr., Bendix Radio Corp.

12:15 P. M. Luncheon Meeting
Speaker: B. D. Hull, Chief Engineer, Southwestern Bell; President, AIEE; "An American Engineering Association"

CONFERENCE

2:00 P. M. Technical Sessions

9. NEW DEVELOPMENTS
   - (a) "Ultrasonic Guidance of the Blind" by F. H. Slaymaker and W. F. Meeker, Stromberg-Carlson
   - (b) "Heatless Preservation with Penetrating Electrons from the Capacitron" by W. Huber, Electronized Chemicals Corp.
   - (c) "Citizens Radio Service" by R. E. Samuelson, Hallicrafters Co.
   - (d) "General Trends in Foreign Electronic Developments" by A. H. Sullivan, Jr., Wright Field
10. INDUSTRIAL ELECTRONICS
    - (a) "Electronic Half-tone Engraver" by John Boyajian, Fairchild Camera and Instrument Corp.
    - (b) "Electronic Servomechanism Testing Machine" by H. W. Katz, University of Illinois
    - (c) "Sealed Ignitrons for Radio Transmitter Power Supplies" by H. E. Zuvers, General Electric Co.
    - (d) "Single Phase Controlled Rectifier and Inverter Circuits" by C. M. Wallis, University of Missouri
11. ANTENNAS
    - (a) "High Gain with Discone Antennas" by A. G. Kandoian, W. Sichak and R. A. Felsenheld, Federal Telecommunication Lab., Inc.
    - (b) "Slot Antennas" by N. E. Lindenblad, Radio Corporation of America
    - (c) "Measurement of Aircraft Antenna Patterns in Flight" by J. S. Prichard, Airborne Instruments Lab., Inc.
    - (d) "Transmission Frequencies for Line of Sight Systems" by L. S. Schwartz, Naval Research Lab.
12. NUCLEONICS
    - (a) "Mass Spectrometer Type Leak Detector" by R. F. Wall, Texas A. & M. College
    - (b) "Scintillation Counter" by J. W. Coltman, Westinghouse Electric Corp.
    - (c) "Precision Studies of Nuclear Reactions" by W. E. Shoupp, Westinghouse Electric Corp.

Wednesday, November 5

9:00 A. M. Technical Sessions

13. MILITARY APPLICATIONS OF ELECTRONICS
    - (a) "Guided Missiles" by W. N. Brown, Jr., Haller, Raymond and Brown
    - (b) "Telemetry System for Guided Missiles" by L. J. Neelands and Walter Hausz, General Electric Co.
    - (c) "Foreign Developments in Infrared" by E. A. Underhill, Wright Field
    - (d) "Foreign Vacuum Tubes and High Frequency Techniques" by B. L. Griffing, Wright Field

A national forum on electronic research, development, and application, sponsored by Illinois Institute of Technology, Northwestern University, the University of Illinois, the American Institute of Electrical Engineers, and the Institute of Radio Engineers, with the cooperation of the Chicago Technical Societies Council.

14. COMMUNICATIONS
    - (a) "Teleran, A Technical Progress Report" by R. W. K. Smith, D. H. Ewing and H. J. Schrader, Radio Corporation of America
    - (b) "Crystal Saver" by W. R. Hedeman, Jr., Bendix Radio Corp.
    - (c) "Pulse Count Modulation" by D. D. Grieg and S. Metzger, International Telephone and Telegraph Corp.
    - (d) "Air Traffic Control" by W. D. White, Airborne Instruments Lab., Inc.
15. BASIC SCIENCE
    - (a) "Semi-Conductors" by K. Lark-Horovitz, Purdue University
    - (b) "Dynamic Properties of the Infrared Cesium Arc" by J. M. Frank and W. S. Huxford, Northwestern University
    - (c) "Supersonic Detection of Infrared Modulation" by F. J. Fry and W. J. Fry, University of Illinois
    - (d) "Microwave Scattering" by R. T. Gabler, Westinghouse Electric Corp.
16. INDUSTRIAL APPLICATIONS
    - (a) "High Frequency Operation of Fluorescent Lamps" by J. H. Campbell and B. D. Bedford, General Electric Co.
    - (b) "Magnetostriction Torquemeter" by C. M. Rifenberg and E. H. Schulz, Armour Research Foundation
    - (c) "Saturable Core Magnetometer Applications" by W. E. Tolles, Airborne Instruments Lab., Inc.

2:00 P. M. Technical Sessions

17. TELEVISION
    - (a) "The Chromoscope, A New Color Television Viewing Tube" by A. B. Bronwell, Northwestern University
    - (b) "Color in Television Cathode Ray Tubes" by E. B. Fehr, General Electric Co.
    - (c) "A Modern Television Transmitter" by C. D. Kentner, Radio Corporation of America
    - (d) "Monitoring Equipment for Television Broadcast" by M. Silver, Federal Telecommunication Lab., Inc.
18. ELECTRONIC INSTRUMENTATION II
    - (a) "High Resolving Power Infrared Recording Spectrometer" by R. C. Ne'son and W. R. Wilson, Northwestern University
    - (b) "The Phase Meter" by E. O. Vandeven, General Electric Co.
    - (c) "Accurate Measurement of Relative Phase" by R. Glaser, Massachusetts Institute of Technology

English . . .

(continued from page 9)

Tech. (It is not the custom of I.I.T.'s English department to be represented.) This group gave its attention to several major educational issues, and gave a corporate answer and emphasis hardly to be found elsewhere in the profession of teaching English at the college level.

Research or teaching?

Every university teacher is confronted with the problem of striking a balance in his own practice between duties as a pedagogue and duties as a productive scholar. It is hardly a secret to anyone, unless possibly to the taxpayers and philanthropists, that the universities exalt research above class-room teaching. It is a rare man who gives himself generously and fruitfully both to the needs of the undergraduate students before him and to the demands of intensive personal investigation. Therefore, most universities do their best teaching at the graduate level, where research and teaching can function together.

Teachers of undergraduates are characteristically apprentices working on doctoral dissertations, or journeymen or masters primarily concerned with "their own work," scholarly investigations which have little connection with their teaching but which are the principal, if not the only, means of winning the favor of administrators. They have a perpetual issue before them: How poor a job of undergraduate teaching will my department head or my conscience permit me to do? Often conscience gets little help from the department head or dean.

With English teachers of the A.S.E.E., this question of research or teaching is not answered as it is in the universities' main-line English departments. The answer is, "Teaching above all, and what is research to us?" At the Minneapolis convention, people stood up in public and attacked the standard insistence upon the Ph.D., the course of study leading to the Ph.D., and pressure for productivity in the learned journals. This would be unthinkable heresy in the Modern Language Association.

Asking myself, "What manner of men are these?" I scanned faculty rosters. Whereas the proportion of Ph.D.'s among teachers of English of professorial rank is 70 per cent at Illinois Tech, it is only 40 per cent at Purdue and precisely zero per cent at Massachusetts Institute of Technology and at Rensselaer Polytechnic. I tried in vain to associate these men's names with title pages. Many of them have not gone through the graduate school process, and few of them are under pressure from within or without to produce esoteric scholarly works. Research is not their business. Teaching is.

Detail or generalization?

Many allegedly humanistic courses in the universities are hardly humanistic at all. The research scholar's passion for thoroughness, for facts in literary history, especially new facts, not infrequently results in a teaching method aimed at inculcating knowledge of facts—dates, sources, influences, parallels, cognates—as well as, and sometimes instead of, the ideas and values asserted and the artistic effects achieved by classic authors. In contrast are teachers of English to engineers, acutely aware of the little time at their disposal and of the shell of indifference or antipathy they often have to overcome. They are not, in general, reseach men.

At the A.S.E.E. convention, they spoke with zeal and fervor of the humanities as humanizing agents. They expressed the paramount desire to influence tomorrow's men of practical affairs towards benignity, tolerance, sympathy, ethical conduct, social idealism. I have never before felt so evangelical a spirit at any secular professional meeting. As one person said, sounding a note of caution, "We seem to be attempting no less than the spiritual salvation of the engineering student, in less than 20 hours!"

Mention was made of the criticism of superficiality, which criticism most were disposed to brush aside. Obviously no thorough humanistic edu-

cation can be accomplished in a technical curriculum. A.S.E.E. English teachers are not disposed, for that reason, to restrict their aims to narrow objectives. Cheerfully admitting superficiality in the students' learning and occasional amateurishness in the facultyman's, they are setting about the task of inducing in students, not a thorough knowledge, but a humble awareness of the field of humane letters.

Another emphasis, emanating from different quarters, was an extreme vocationalism, an alignment of every assignment with specifically practical situations, and a repudiation of much of any attempt at general or liberal education. This adaptation to utilitarian objectives was, however, a minor theme at Minneapolis, and advocated chiefly in connection with freshman composition.

It should be stated that both the immediately utilitarian and the cultural functions of teachers of the humanities have been accorded hearty recognition by the A.S.E.E. Concern for humanistic teaching in engineering colleges is by no means confined to teachers of that subject matter, but appears to be general throughout the Society.

How to use time given non-technical subjects?

In the universities, the "humanistic-social" departments live quite independently of engineering students, and compete for liberal arts students. In most institutes of technology, non-technical instruction is often concentrated in a very few departments with well defined but in-

clusive boundaries. Seldom is there a situation favoring a collision of interests between literature on the one hand and the social sciences on the other.

Repeatedly the point was made, and needs to be made in the future, that freshman English should not be charged against time reserved for humanistic study. As M.I.T.'s chairman said, the attempt to make freshman English a humanistic course yields neither skill nor knowledge. It is a badly needed pair of courses in fundamental language skills, little more humanistic than freshman mathematics.

As stated above, more advanced non-technical courses in some schools have comprehensive aims little short of salvation. A California Tech spokesman asked M.I.T.'s chairman where he found the encyclopedic minds able to cope with the all-inclusive course sequences of the Massachusetts department of English and history. Bravely and perhaps rashly, the teachers of English on the faculties of engineering schools are attempting great ends in the few hours allowed them.

To secede or not to secede?

The contrast between an English conference of the A.S.E.E. and a Modern Language Association convention is astounding. On the one hand: teaching, general wisdom, great breadth with little thoroughness; on the other hand: research, detailed knowledge (sometimes set before wisdom), great thoroughness and specialization. In view of this contrast, some university men view teachers of English in engineering colleges as outcasts; and some of the latter advocate open secession from the main body of the profession of collegiate English professors.

Many of the A.S.E.E. English teachers may be making a virtue of a necessity—the necessity of staying for life in technical schools and giving up all prospects and ambitions of teaching in liberal arts colleges and universities. This necessity is an almost automatic function of having neither a doctorate nor a bibliography.

Recommendations for a new teacher-training program for engineering college English departments are being sought. Some time ago Harvard and M.I.T. planned a program of correlated graduate study and the teaching of engineers that would prepare men specifically for "engineering English." This program was a war casualty before inception, but it may well develop soon.

The secessionists by no means comprise all the A.S.E.E. English personnel. There was no test of strength at Minneapolis between opposing points of view, so I cannot hazard even a guess about proportions. But the secessionists are weighty in numbers and prestige.

There can be no question that an unmodified university-type program and faculty in English cannot best serve the interests of the engineering student. The university-type program is too full and time-consuming to be admitted to engineering curricula. The university-type faculty is likely to have some members who are so preoccupied with publication and so little interested in under-class teaching that they will not establish very effective lines of communication with engineering freshmen. Repudiation of the university pattern in course work and faculty personnel is one possible policy. Modification is another, which I.I.T. has an unequaled opportunity to develop.

I.I.T.'s unique opportunity

I.I.T. has a dual organization—a division of engineering and a division of liberal studies. It is the heir of both Armour and Lewis, and it is dedicated in perpetuity to offer the public both engineering and liberal studies curricula. Its department of language, literature, and philosophy thus has a double function in English: to serve the engineering students in two ways—utilitarian courses in language skills and liberal courses in the humanities; to serve the liberal arts students with everything from an occasional elective to a full major. At present, most of its students are engineering students, and our department's function in part is comparable to that of our co-

workers at M.I.T., Case, Cooper Union, etc., and not to that of English departments at Harvard, Chicago, Northwestern, Illinois, etc. But we face responsibilities and hold expectations in common with university staffs (other than "engineering English" ones), and thus differ from English departments at every other institute of technology in the country.

We are called upon to achieve an educational synthesis, no less.

Over a period of years the administration of I.I.T. has endeavored to maintain an English staff that could compare qualitatively in professional standing with that of a first-class university. Professional standing is determined for the most part by degrees and publications; good teaching hardly ever wins more than local recognition, and not always that. Degrees mean research, as does academic publication, usually. Yet I.I.T.'s teaching load in English is far more than half a matter of teaching freshman English to engineers. This task, professionally considered humble, has been shared by all ranks. To be done with satisfaction to all concerned, such teaching needs to be done by persons of strong devotion to teaching as an end in itself.

I.I.T.'s English department needs to retain and attract both scholars and teachers, preferably in the same persons, but better in different persons than not at all. More urgently than at other schools, the answer at I.I.T. needs to be research *and* teaching—more publication than in most technical schools, better undergraduate teaching than in many universities. At technical schools the English professor's research and teaching cannot often fuse, as at the graduate level, so attention and encouragement must be given both research and teaching, as separate considerations.

I.I.T.'s English courses must be sufficiently solid and factual to serve as a basis for graduate study in English, yet at the same time they must be sufficiently popular and inspirational to stimulate and have meaning for the engineering student with little past and no future in collegiate English studies. We cannot indulge without modification the university professor's single-hearted pursuit of depth. Our professional position calls on us to be both deep and wide, so far as is humanly possible.

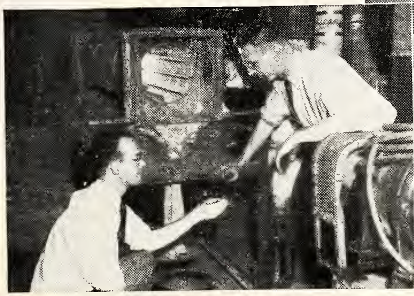
At I.I.T., the English professors need the engineers — and know it. That English literature is crowded out of the engineering curricula at Illinois occasions little thought or distress in the English department there. At I.I.T., this cannot be so. We can continue to offer a major and can maintain a strong department only if our non-engineering students are joined, in nearly all classes, by substantial numbers of engineers. I.I.T.'s non-technical work is departmentalized more fully than that of other institutes of technology, and those departments of slight vocational appeal (e.g., English) especially require the consideration of their colleagues in other departments. Also, we join other engineering educators in urging our engineering and social science colleagues, and our students, not to think of our tool courses for freshmen as comprising in any significant part the humanistic element essential to all respectable collegiate curricula.

Especially, I.I.T. has a solution to the question of secession. I.I.T.'s English staff cannot secede from the main professional pattern without a complete change of direction and an almost total replacement of staff. At the same time, it has never been able to follow the conventional university custom of excusing the senior staff members from all, or nearly all, underclass and composition teaching. To speak in institutional symbols, our task is to demonstrate that men and women who are among their peers in the Modern Language Association also have a significant contribution to make in the work confronting members of the American Society for Engineering Education. In succeeding in this task, our department will be striking a balance between teaching and publication, between popular and esoteric functions, between the diffusion and the increase of knowledge, such as will exist in all too few engineering or other colleges.

Du Pont *Digest*

Items of Interest to Students of Science and Engineering

Fundamental Engineering Studies



Studying product development in an experimental rotary dryer. H. J. Kamack, B. S. Chemical Engineering, Georgia Tech. '41; F. A. Gluckert, B. S. Chemical Engineering, Penn State '40.

Inspecting the interior of experimental spray dryer after a run. W. R. Marshall, Jr., Ph.D. Chemical Engineering, Wisconsin '41; R. L. Pigford, Ph.D. Chemical Engineering, Illinois '41.

In a company like Du Pont the diversity of chemical operations is great and the investment in equipment is high. In addition to the engineering work done in the ten industrial departments, the responsibility for design and construction of manufacturing plants is undertaken by the central engineering department, which also maintains an engineering research laboratory. This laboratory is staffed by chemical, metallurgical and mechanical engineers, and physicists, whose function is to carry on fundamental and pioneering-applied research to develop new methods of processing and equipment designs; improve equipment, materials of construction, and methods of measurement and control; and establish fundamental relationships in unit operations and unit processes.

For example, a broad project was undertaken to study the fundamentals of rotary drying. A principal objective of the study was to learn the effect of the operating variables on the volumetric heat transfer coefficient. Of the numerous variables that affect the drying rate of such a dryer, the more important ones studied were: (1) feed rate, (2) dryer rotation rate, (3) air rate, (4) air temperature, (5) number of flights, (6) direction of air flow, and (7) dryer slope.

Studies on a Laboratory Scale

Fundamental studies of heat transfer and mass transfer were made in a laboratory scale rotary dryer, 1 ft. in diameter by 6 ft. long. To determine the true heat transfer coefficient, special methods were devised to measure the material temperature along the length of the dryer and to measure continuously the temperature of the rotating shell. These determinations permitted an analysis of all the heat transfer effects in the dryer; namely, from air to solid, from shell to solid, and from air to shell.

From a knowledge of the material temperature along the dryer, it was possible to calculate the air temperature at each point in the dryer and thereby to determine point values of the heat transfer coefficient. This procedure permits the calculation of a more accurate average temperature difference, which gives more accurate heat transfer coefficients than can be obtained from terminal conditions only.

During the course of the study, every opportunity was taken to obtain heat transfer data on large-scale plant dryers in order to establish scale-up factors. This procedure permitted the correlation of heat transfer coefficients from a 1 ft. diameter dryer with those of full plant size.

Paralleling the work on the fundamentals of rotary drying operation, problems involved in product and process development received continuous attention. These usually require an investigation of the important auxiliary problems of: (1) material handling to and from the dryer, (2) removal of dust from the air, (3) sealing the space between the rotating shell and stationary breeching, and (4) corrosion of the dryer shell.

How the Results are Applied

The findings of the effect of holdup on dryer capacity were applied to an 8 ft. standard rotary dryer producing 300 lb./hr. of granulated material. The information obtained on this factor alone permitted an increase in capacity of 75 to 100%. This meant an increase of over a million pounds annually. Further, one dryer could now handle the load of two, releasing second dryer for other work.

The information developed in such fundamental studies permits more accurate design of equipment for future operations resulting in lower cost of manufacture and lower investment.

Casting . . .

(continued from page 12)

drains out of the mold into the ladle. After draining, the remaining casting is a cylinder with a wall thickness determined by the holding period. Because there is but one mold interface from which solidification begins, there can be no centerline porosity.

The drain-back of the gates and runners can be used to advantage to increase the metal yield on light-section castings, in which the individual gates on the castings freeze before the heavy up-gate and runners solidify. The procedure usually followed on all counter-gravity castings is to hold the vacuum until the castings have solidified and then allow the gate and runner metal to drain back into the ladle.

The use of the drain-back procedure would be of ultimate advantage in a production line operation, where the metal would be drawn from a heated holding ladle or furnace under the counter-gravity nozzle. Such a procedure could produce yields as high as 80 percent for steel castings where extensive risers are not required. Extended holding time of metal in an induction furnace has shown no detrimental effects on the properties or soundness of several grades of steel.

Examples of some of the large variety of castings poured by the counter-gravity method are railroad car couplers (weight approximately 100 lbs.), aircraft landing gear scissor-castings (weight approximately 1 lb.), oil well cross-cutters, landing gear cylinders, motor supports, tank track links, brake shoe-heads, coreless bushings, billets, cannon yoke, shells, and other miscellaneous parts.

In most cases a large number of castings of the same design are cast from one common gate into dry sand molds. In fact, the process is best adapted to repetitive operation on large production runs of the same part, or to smaller quantities of special parts which are cast with difficulty and with resulting poor yields by gravity methods.

A multiple runner system is generally used for large quantities of

Landing Gear Scissors successfully cast by means of the counter gravity casting method.

small castings, each runner having many molds assembled above it and closely packed. As many as 112 landing gear scissor-castings have been poured in one mold assembly (see Figs. 3 and 4). The rather crude clamping set-up for the scissor-casting molds shown in Fig. 4 would be replaced in production by a quick-acting, vacuum-applied clamping device.

The pouring station in the general production shop is usually on a conveyor line, or it sometimes covers a large floor area. With the counter-gravity pouring method, all pouring and metal handling operation can be located adjacent to the melting equipment; and a minimum of time and travel with molten metal will be required. Only one man is required for the actual pouring operation. Molten metal hazards are at a minimum because the pouring is done in a closed chamber, which eliminates the danger of run-outs, spill-overs, etc. The smoke and gases generated while pouring are evacuated and exhausted directly out-of-doors causing no unpleasant odors or smoke. After casting, the molds can be rolled directly into a shake-out station which is well ventilated. Such a foundry would really be "a good place to work."

Atomic . . .

(continued from page 14)

ity generated from coal at the mine (provided an adequate supply of condenser water is available). Almost all generating stations of any size produce electricity at a cost below 9 mills.

From these figures, it does not appear that the "atomic revolution" is going to be a very sweeping revolution after all, so long as atomic energy is restricted to electric generation. Of course, we can expect that a new technology will undergo a whole series of improvements, and that the cost of building an atomic plant now may be substantially higher than it will be 15 years from now. It is idle to speculate how rapid such improvement will be, but the data now available do not give any grounds for believing that atomic electricity will be generated at a cost much below 4 mills per KWH in the visible future.

Economic effects of cheap power

Let us go one step further and assume that atomic power can actually be produced at a cost several mills lower than the present cost of electricity. How much would this mean to our economy? In 1944, about 280 billion KWH of electricity were generated in the United States, including electricity produced by industrial establishments for their own use. Each mill per KWH reduction in generating costs would therefore represent a saving of $280,000,000 per year to the economy. The total national income in 1944 was $160,000,000,000. Hence, the resources saved by each mill of cost reduction could, if applied to other uses, increase our national income by perhaps one-sixth of 1 per cent.

Even an eight-mill reduction in cost—a very unlikely eventuality—would increase the national income by only 1½ per cent. Or, if we wished to consume this increased income in the form of leisure rather than products, we could shorten our 40-hour week to a 39½-hour week, or take four days extra annual vacation. This is a very pleasant prospect, but hardly an economic revolution.

It may be argued that we have not considered the possible indirect effects of the availability of cheap power. If power were cheaper, it could be used more freely in industrial processes, with a consequent increase in the productivity of each worker. Moreover, products which, like aluminum, require a great deal of electricity for their production would become cheaper and could be substituted for more expensive products (e. g. the light metals for iron and steel).

The above argument is correct only when important qualifications are attached to it. It is true that there is a very close relation between the productivity of an economy and the amount of power consumed per worker; but mechanization involves

(please turn to page 36)

If you can catch a leprechaun...

A leprechaun, according to Irish legend, is a dwarf who keeps a pot of gold hidden away.

If you can catch a leprechaun, your troubles are over.

Because he keeps his gold just for ransom money. If you catch him, he'll quickly tell you where his gold is, so you let him go.

The best place to look for a leprechaun is in the woods. They're green, and only about nine inches tall, so you'll have to—

Or maybe you don't believe in leprechauns.

Maybe it would be more practical to just keep working for your money. But you can learn one good lesson from these little fellows. A small pot of gold put to one side is a great help when trouble catches *you.*

And there's a much faster and easier way to get your pot of gold than by catching leprechauns. You can buy U. S. Savings Bonds through an *automatic* purchase plan.

If you're employed you can sign up for the Payroll Savings Plan. If you have a bank account you can sign up for the Bond-A-Month Plan. Either way, your pot of gold just saves itself, painlessly and automatically.

And your money increases one third every ten years. That would make a leprechaun turn even greener with envy.

Save the easy, automatic way—with U.S. Savings Bonds

Contributed by this magazine in co-operation with the Magazine Publishers of America as a public service.

(continued from page 34)

not merely a substitution of mechanical power for hand labor but a substitution of mechanical power and *power machinery* for hand labor. The cost of the mechanized process is not merely the cost of the power consumed, but, in addition, the fixed and operating charges for the power machinery and other capital plant required.

How far it is profitable to mechanize depends on how large are these overall costs. Since in most manufacturing processes fuel and power represent less than 5 per cent of the value of the product, it is not often that a moderate reduction in power costs will make mechanization profitable where it has not been before. Once power rates have reached a moderate level, the amount of capital available in an economy for investment in machinery will be far more important than the cost of power in determining how much power will be consumed.

Likewise, it is hard to find illustrations of cases where a mere reduction in power costs will cheapen the final product sufficiently to lead to large-scale substitution for other products. Even in the case of aluminum, the cost of electricity probably represents only one-fifth of the cost of the product. A 50 per cent reduction in power costs for this industry would permit only a 10 per cent reduction in the price of the product.

Atomic energy is available anywhere

Thus far no mention has been made of one of the most important characteristics of electricity generated in an atomic plant—it can be produced at about the same cost at virtually any place it is wanted. Hydroelectric power must be used very near the damsite—or large charges must be incurred for transmitting it elsewhere. Power from coal stations must bear the cost of transporting the coal from the mine, hence it can be had at moderate cost only within a limited radius from coal fields. In the atomic plant, the fuel can be transported anywhere almost without cost. Only local differences in construction costs and differences in the availability of condenser water —if that is required by the plant— can lead to major differences in the cost of producing the power.

The present location of industry in the United States and throughout the world is closely dependent upon the location of deposits of coal and iron and of developed water power sites. In some cases raw materials are carried long distances (e. g. alumina) in order to be processed where cheap power is available. Atomic power, because of its indifference to geography, might permit a far more flexible pattern for the location of industry and might permit industrialization in areas where this would not otherwise be feasible.

Here again, caution is needed in assessing the possibilities.

In the first place, atomic power will be "available everywhere" outside the United States only if a workable scheme of international control can be devised and if the individual

(please turn to page 38)

Ultrasensitive RCA Television camera tube cuts studio light requirements 90%

Television finds drama in the dark — with new RCA studio camera

Now television becomes even more exciting as lights are dimmed, and the camera reaches deep inside studio shadows to capture action as dramatic as any on stage or screen . . .

A new studio television camera—developed by RCA scientists and engineers—needs only 1/10th the usual amount of light.

The super-sensitive eye of the new camera is an improved Image Orthicon Tube . . . of the type once used only outdoors. With it, studio broadcasts are sharper, clearer—and since so little illumination is needed, heat in the studio is sharply reduced. No more blazing lights!

Such improvements come regularly from research at RCA Laboratories, and apply to all branches of radio, television, electronics, and recording. These improvements are part of any product bearing the name RCA or RCA Victor.

• • •

When in Radio City, New York, be sure to see the radio and electronic wonders at RCA Exhibition Hall, 36 West 49th St. Free admission. *Radio Corporation of America, RCA Building, Radio City, New York 20.*

Continue your education with pay—at RCA

Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short wave and FM circuits, television, and phonograph combinations).
- Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.
- Design of component parts such as coils, loudspeakers, capacitors.
- Development and design of new recording and reproducing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

Write today to National Recruiting Division, RCA Victor, Camden, New Jersey.

Also many opportunities for Mechanical and Chemical Engineers and Physicists.

RCA

RADIO CORPORATION of AMERICA

(continued from page 36)

nations are persuaded to accept it.

In the second place, important segments of heavy industry would, in any case, continue to be attracted to the iron mining regions.

In the third place, even now there are many important industries (e. g. textiles) in which power costs are relatively unimportant and which are often located in areas with fairly high power rates.

In the fourth place, coal is used as a chemical as well as a fuel; and electricity could not be substituted for it, without other changes in technology, in some of its uses. For example, it is highly problematical whether electrical reduction of iron ore could compete with blast furnaces even if electricity were very cheap. Several theoretically possible methods of electrical reduction of ore to sponge iron are known, but their practicability has by no means been demonstrated.

Industrialization of backward countries

Almost all the "backward" countries of the world today are looking to industrialization as the primary solution for their problems of poverty and over-population. But in most instances, the maximum rate at which this industrialization can proceed will be limited more by the scarcity of skills and technological knowledge and of the capital needed to build factories and machinery than by the lack of power resources. China's coal supply would last at least 300 years, and India's 80 years, even at the American per capita rate of consumption, and their supplies will last far longer at the lower consumption rates that these countries are likely to achieve.

To be sure, there are exceptions. Even before the war, the expansion of Japanese industry was pressing against the limits of the coal supply, and the best hydroelectric sites had already been almost fully developed. South America is very deficient in coal; and, although there are great potentialities for hydroelectric development, the favorable waterpower sites are hundreds of miles from the principal areas of industrial development. Coal could be imported cheaply by water; but, since very large amounts of foreign exchange would be required to pay for this coal, a major industrialization based on imported coal appears beyond the financial reach of these countries. In India, although the aggregate coal supply is large, it is mostly concentrated in the northeast, near Calcutta, and atomic power would very greatly facilitate the industrialization of the southern and western parts of the peninsula.

These examples serve to indicate that the development of a practicable atomic power plant, even though unable to product electricity much below the cost at favorably located coal or waterpower stations, may be of considerable importance in the industrialization of areas of this kind.

If these estimates of the significance of atomic power seem too conservative, if we are convinced that a technological innovation of such a radical kind must of necessity bring about equally radical changes in our economy, we must remember that these predictions refer to a limited area of application—the use of the atomic pile to produce electricity.

If effects of really revolutionary scope are to appear, they will most probably come about through the invention of entirely new applications of the atomic pile (just as the effects of the internal combustion engine and electricity were produced through such inventions as the automobile and the radio) rather than simply through a cheapening of power. Already, one of these applications has appeared on the scene—it antedated, in fact, the invention of the self-sustaining pile. I refer to the use of radioactive tracers in biological research and medicine. This application and others yet to be discovered seem far more likely to produce the Atomic Revolution than does the production of cheap electricity.

A. A. A. S. Plans Chicago Convention

THE 114th convention of the American Association for the Advancement of Science will be held December 26-31 in Chicago. General headquarters for the annual meeting will be the Sherman Hotel. Those who plan to attend may register now through the Washington, D. C., office of the association, 1515 Massachusetts avenue, N. W. Registration fee is $2 for members and college students, $3 for non-members.

General programs will be mailed December 1 to all who register before that date. This will permit each registrant to study the contents and decide at leisure which of the several hundred sessions and special functions he may wish to attend. The name of each early registrant will be included in a special directory available for inspection at headquarters hotels when the sessions begin.

Lists of papers for the sections and societies meeting with the association, including time and place of each, will be included in the general program. It will also contain announcements regarding general sessions, the International Science Exhibition, eating facilities, transportation, mail and messenger service, and a directory of speakers and presiding officers.

Registration fees have been received since August 15; they will be accepted for mail distribution of the general program until December 10. Payments after that date will be placed on file December 26 at the main registration center in the Stevens hotel. Upon identification, these registrants will be given a copy of the general program and their cards placed in the visible directory. To avoid delay in receiving programs during the Christmas mailing rush, those who plan to attend are urged to mail the registration fee to the Washington office prior to December 1.

Steels . . .

(continued from page 17)

bon and goes into solution in the iron.

An example of this is afforded by the stainless cutlery steels. The prime requisites of a good knife are high hardness and good abrasion resistance. In simple carbon steels this is obtained by using carbon up to 1½ per cent (and, of course, quenching and slightly tempering). To impart resistance to attack by food acids, chromium must be added. If the minimum amount of chromium is to be added to produce this property for economy reasons, the carbon must be very low, less than 0.1 per cent. The only way any degree of hardness can be given to this steel is by cold working. Such knives are blanked out of cold rolled strip.

These were the first stainless knives given to the public in large quantities and were responsible for the widely held opinion that stainless knives are worthless as cutting implements. Knives can be made really stainless and with very sharp edges, but they are necessarily much more expensive. Hardness must come from high carbon, over 1 per cent. To have the required chromium in solution for corrosion resistance, the chromium content must be over 18 per cent. Furthermore, the steel must be solution-treated at a high temperature.

The iron-chromium-carbon alloys are ferritic, that is, the iron and chromium atoms are arranged to form the corners and at the centers of cubes. While these alloys can have good corrosion resistance if the chromium is sufficiently high, their structure does not permit much strengthening by cold working; furthermore, they are welded with considerable difficulty.

When nickel is added to these alloys, the structure of the alloy changes to the austenitic, or face-centered cubic structure, wherein the iron, chromium, and nickel atoms are arranged to form the corners and faces of cubes. Such a structure work hardens very readily. The steel containing about 18 per cent chromium and 8 per cent nickel (18-8) has excellent corrosion resistance and can be drawn to wire having rupture strength exceeding 300,000 lbs. per square inch.

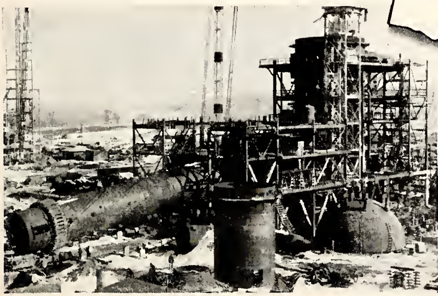
The ubiquitous carbon can exert a deleterious effect on this type of steel. When the steel is held in the range of 1250° F. for a few minutes, the carbon and chromium come out of their solution in the cubic structure and form their own union, the carbide structure. Since one atom of carbon takes out four atoms of chromium along with it, not much carbon is needed to deplete the steel of chromium in solution from the sites where the precipitation is occuring.

Such a phenomenon, called intergranular precipitation because of its locale, leaves the steel in a condition readily susceptible to acid attack. A strip of this steel in such condition can be crumbled in the fingers after it has been exposed a few hours to a dilute boiling solution of copper sulfate and sulfuric acid. Fortunately,

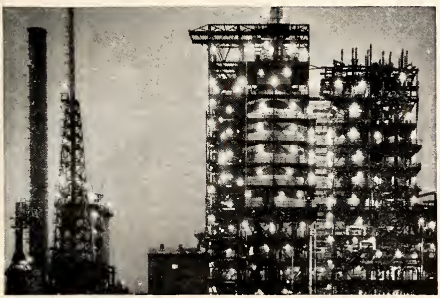
(please turn to page 44)

Floating 2,081 Miles to make a Cracker

1. The tower in the picture is 108 feet long, over 16 feet in diameter. It weighs 155 tons. At the Atlantic Coast plant where it was built, the job ticket read, "Fractionating tower for catalytic cracking unit, Standard Oil Company (Indiana)." Too big to be shipped overland, it had to go by water to Standard's refinery at Sugar Creek, Missouri, near Kansas City—a matter of 2,081 miles!



2. The tower was timber-cribbed and floated, towed up New York Harbor and the Hudson River, across New York State by canal. A tug took over the towing job through Lakes Erie, Huron and Michigan, riding out a storm en route. Then the tower was loaded on a barge to complete its journey via the Illinois, Mississippi and Missouri Rivers. This winter at Sugar Creek, the cat cracker of which this tower is part goes on stream, joining similar units already operating at other Standard refineries. It has a charging capacity of 25,000 barrels a day!



3. Like our Burton Stills in 1913 and continuous units of 1932, catalytic crackers are milestones in petroleum progress. Today at Standard, the industry's ablest engineers and research men are developing new . . . and better processes and products. Men of the same type are coming from leading colleges of science and engineering to start work at Standard. Here they find unexcelled technical facilities for research and design. If you want a career with splendid opportunities to advance and make real contributions, you should get to know Standard better.

Standard Oil Company
(INDIANA)
910 SOUTH MICHIGAN AVENUE, CHICAGO 80, ILLINOIS

STANDARD SERVICE

(continued from page 42)

specifics for this ailment are known. The most effective is a carbide stabilizing element, such as columbium, which has a greater attraction for carbon than has chromium.

Although 18-8 steels are normally austenitic and non-magnetic in their soft condition, severe cold working, such as wire drawing, produces a partial transformation to the ferritic state, which is magnetic. Advantage is taken of this phenomenon in producing wire for the wire recorder. The finely drawn 18-8 wire has excellent corrosion resistance, high strength, and good magnetic properties.

An interesting application of austenitic stainless steels (principally 25 chromium and 20 nickel) is in the welding of hardenable steels. The rapid cool from the high welding heat will produce the hardening transformation in low alloy steels such as used for armor plate. The high stresses resulting yield a weld of low impact properties. If the weld rod used is of the austenitic type, the stresses are evenly distributed throughout the soft, but tough weld.

Closely allied to resistance to chemical attack is resistance to heat. Under the classification of heat-resisting steels are those steels primarily used for oxidation resistance, or freedom from scaling at high temperatures, and those steels primarily used for high strength at elevated temperatures.

Resistance to scaling increases as the iron content decreases. A widely used steel for this purpose contains about 30 per cent chromium, balance iron, with 0.25 per cent carbon. The conditions in the combustion chamber of a household oil burner are such that a steel with 18 per cent chromium will suffice, while a carburizing box to operate many hours at 1700° F. is made from an alloy containing 70 per cent nickel, 18 per cent chromium and only 12 per cent iron. Whether the alloy is ferritic or austenitic does not seem to make much difference for scale resistance.

All of the alloy steels for high strength at high temperatures are of the austenitic type. Just as the addition of tungsten or of molybdenum to carbon steels increases the retention of hardness at elevated temperatures, likewise the addition of tungsten or of molybdenum to an 18-8 base stainless steel increases the retention of strength at elevated temperatures. In these alloys, moreover, the high strengths must be maintained over long periods of times, up to 100,000 hours.

The success of the jet plane depended on the discovery of these alloys, and the further development of jet propulsion is directly dependent upon furthering the ranges of the present steels. As the cutting tools of the future will contain little, if any, iron, so will the high temperature alloys of the future. These alloys will be principally made up of cobalt, chromium, nickel, tungsten, molybdenum, and columbium.

We have seen how types of special steels have been developed for the special purposes of our present-day civilization. The age of atomic power into which we are moving will see the development of new steels containing elements which only a few years ago were too rare even to be laboratory curiosities, such as gallium, and elements which did not even exist, such as plutonium.

Man has demonstrated his ability to control and adapt nature to fit his advancing physical needs. Let us pray that he can soon learn to develop the same abilities to satisfy his spiritual and social needs.

IGT...

(continued from page 20)

(1) A study of the steam-carbon-oxygen reactions, to develop a better understanding of the fundamentals which control the processes of gas making.

(2) A study of catalysts for the decomposition of hydrocarbons of low molecular weight as carrier gases for subsequent enrichment, consisting of a laboratory study of sulfur-resistant catalysts and a pilot plant study of the steam-air-hydrocarbon ratios, temperatures, and space velocities upon operating efficiencies.

(3) A study of the adaptation of the fluid and thermofor catalytic cracking processes to the gasification of oil and/or coal.

A study of the equipment necessary to evaluate oil for gasification has resulted in an appropriation of $10,000 by the American Gas Association, through the Gas Production Research Committee, to establish the necessary facilities at the Institute

(please turn to page 48)

TABLE II *Roster of Students* **Entered—1946**

Fellow	*School and Degree*	*Entered From*
Chapin, Dougles S.	Kansas State College, B.S. Chem. 1/29/44	U. S. Army, T/4 Medical Dept.
Cook, Richard H.	Syracuse University, B.S.Ch.E. 12/1943	U. S. Navy, Lt. (jg) Communications and Electronics
Dow, Willard Matt[1]	Colorado School of Mines, B.S., Pet. Eng. 1942; M.S., IGT, 1945	U. S. Navy, Lt. (jg)
Halvorsen, Wm. J.	Virginia Polytechnic Inst., Ch.E., 6/1942	Standard Oil Company (New Jersey) Baton Rouge, La., Chem. Engineer
Kelly, James H.	Louisiana Polytechnic Inst., B.S.Ch.E., 5/1943	Standard Oil Company (New Jersey) Baton Rouge, La., Chem. Engineer
Luntey, Eugene H.	University of Idaho, B.S.Ch.E., 1943	U. S. Navy, Lt. (jg) Radar
Selph, John W., Jr.	Vanderbilt University, B.E., 1942; M.S., IGT 1947	U. S. Navy, Lt. (jg) Eletronics

[1] Thesis: (Master's) Heat Transfer from a Surface to Air in a Parallel Flow.

Entering—1947

Fellow	*School and Degree*	*Entered From*
Brooks, Robert	Purdue, B.S.Ch.E., 1947	Purdue
Coley, Francis	Virginia Polytechnic Inst., B.S.Ch.E., 1943	Tenn. Eastman Corp.
Ellington, Rex E. Jr.	Univ. of Colorado, B.S.Ch.E., 1943	Mass. Inst. of Tech., Operations Evaluations Group
Garver, John	Univ. of Wis., B.S.Ch.E.; M.S., 1947	Univ. of Wis.
Helbling, Don	Ill. Inst. Tech., B.S.Ch.E., 1947	U. S. Navy, Ensign
Owen, Henry Jr.	Texas A. & M., B.S.Ch.E., 1942	Celanese Corp. America
Peres, Ernest	Tulane Univ. of La., B.E.Ch.E., 1947	Tulane Univ. of La.

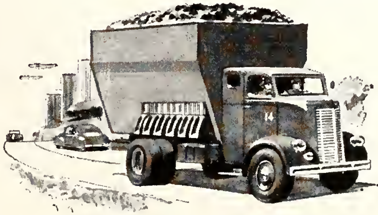
TABLE III *Roster of Graduates* ***Doctor of Philosophy***

Name	*Year*	*Dissertation*	*Present Location*
Robison, Henry E.	1941-1946	Particle size distribution by Beaker Type Centrifugal Sedimentation	Armour Research Foundation

Masters of Science

Name	*Year*	*Dissertation*	*Present Location*
Dow, Willard M.	1942-1944	Heat Transfer from a Surface to Air in a Parallel Flow	I.G.T., Ph.D. Candidate
Newhall, Robert M.	1941-1944	Oxidation of Quinoline	Standard Oil Devel. Co.
Pelican, Thomas L.	1942-1944	Dehydrogenation of Propane by Means of Chromia-Alumina Catalyst	Nat. Gas Pipe Line Co. of America
Savory, Leonard E.	1942-1944	Gas Jet Radiation Generator	Univ. of Denver
Selph, John W. Jr.	1942-44, 1946-47	Porous Plug Viscometer for Gases	Eastern Gas and Fuel Associates
Strong, Erwin R.	1942-1945	Composition of Propane Hydrate	I.G.T. Staff

When you admire a beauty[1] . . . or visit a farm[2] . . .



ride on a ferry[3] . . . . or order some coke[4] . . .

swallow an aspirin[5] . . . . or turn on the light[6] . . .

the chances are, you are coming in contact with Koppers engineering or chemical skills.

1. Koppers chemicals for use in cosmetics. **2.** Farm structures made of lumber pressure-treated by Koppers for long life. **3.** Koppers American Hammered Piston Rings for marine engines. **4.** Coke from Koppers-built ovens. **5.** Koppers chemicals for use in medicines. **6.** Koppers Fast's self-aligning couplings, widely used in power plants. All these are Koppers products . . . as well as scores of others that help to increase our comfort, guard our health, enrich our lives. All bear the Koppers trade-mark, the symbol of a many-sided service . . . and of high quality. Koppers Company, Inc., Pittsburgh 19, Pa.

K

KOPPERS

(continued from page 46)

for evaluating oil for cracking and for determining the composition of the residual tar. This laboratory, which will be an integral part of the facilities for hydrocarbon identification, is under process of development at this time and will materially improve the facilities available at the Institute.

It has been the considered opinion of the Institute's executive committee that the research facilities and activities could be most intelligently expanded if the present problems confronting the Gas Industry were presented by those who were most actively engaged in their successful solution.

Two committees of the American Gas Association — the Gas Production Research Committee and the Technical Advisory Committee—are composed of men outstanding in their field and keenly aware of the research needs of their industry. Because of the close relationships existing between this association and the Institute, these committees have been of inestimable service to the Institute by keeping the director and his staff apprised of the direction of their thinking and of the probable course of future developments.

A great need has been demonstrated for research in natural gas and ancillary fields. The formation of the technical and research advisory committee was considered a necessary step in the development of such research. A preliminary organization meeting May 1 in Chicago was attended by many leaders in this field. As a result, Eastern, Southwestern, and Pacific Coast sub-committees were formed so that needs specific to an area, as well as those applicable to the industry as a whole might be considered carefully. Subsequent meetings of the sub-committees here resulted in the presentation of a large number of excellently-conceived and extremely pertinent problems for research.

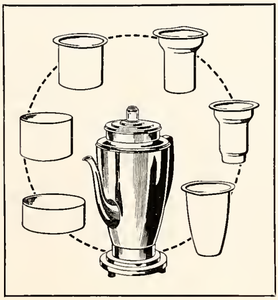
These and further activities of the committees will serve to guide the purchase of research equipment and to indicate the direction in which the Institute's studies should proceed.

BUSINESS IN MOTION

To our Colleagues in American Business . . .

There is a handsome electric percolator coming on the market in increasing numbers. It wins sales by its beauty and by the name of its maker. What the people who buy it do not know about it is that Revere collaborated closely with the manufacturer in working out ways and means of speeding production and lowering costs.

The base metal is Red-Brass, 80%, supplied in sheet form. Forming the tall and graceful design requires a number of draws to increasing depth. Yet only one anneal is required, after the first two draws and before a reverse draw. In the latter the annealed shell is turned completely inside out, giving additional depth and at the same time producing the pressure-pad flange required for subsequent operations.



In deep-drawing work, grain size is the controlling or limiting factor. Before Revere and the manufacturer collaborated on this product and established precise grain size control for the metal, it was occasionally necessary to resort to an additional spinning operation in order to smooth the sidewall of the shell produced by the last draw. Our recommendations, not only with respect to the raw material as received by the customer, but in various processing steps, assisted toward a substantial reduction in the costs of production, and likewise in the costs of polishing and buffing before chromium plating.

Naturally, both we and our customer are delighted with the success of our mutual efforts, but to our minds the most important thing about this case history is the fact that the customer went far beyond merely ordering Red-Brass in such-and-such a size, gauge and temper. He took us completely into his confidence as to fabrication methods and requirements. Only in that way was our knowledge of our metals successfully added to the customer's outstanding manufacturing ability.

Perhaps your products do not use our metals, or any metal at all. It does not matter. What we want to point out is that you can obtain from your suppliers much more than materials. When you buy these you pay not only for the feet or tons or gallons you get, but also for the knowledge and experience required to produce those materials. You pay for both products and brains — why not use both? No matter what you buy, nor from whom, we firmly believe that you can benefit by giving your suppliers full information concerning your production problems and thus adding their brains to your own.

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

☆ ☆ ☆

Executive Offices:

230 Park Avenue, New York 17, N. Y.

Germany . . .

(continued from page 22)

This unchanging passivity led Wiechert to victory. In one of his recent letters to me he wrote that on his lecture tour of Switzerland this year people everywhere were showering love, and nothing but love, upon him. "All this", he added joyfully, and with a certain sadness, "all this after all those years."

About the time of the publication of Wiechert's *Forest of The Dead*, several other books came out which tried to interpret or clarify the events of the recent past. They were all written some time after the occurrence of the events, and because of this interval they manifest greater discipline and a somewhat broader survey.

The president of the University of Marburg, Julius Ebbinghaus, in his book, *Fate Turns to Germany*[6], is the first to deal with the question of guilt. Interest in this question has been continued in a more philosophical and legally accurate way by Professor Karl Jasper in his book, *The Question of Guilt*[7]. The main theme in these and other works is the definite acceptance of the idea that Germany is to blame. These authors make no attempt to refute it. After admitting this guilt, the whole problem appears to be projected in a way which seems more favorable to the Germans than if they had denied guilt *a priori*.

While President Ebbinghaus tries to illuminate this particular problem, two others, Wilhelm Hoffmann, librarian of the Swabian State Library, and the Göttingen professor, Friedrich Meinecke, explore the past in order to gain a better survey of the whole situation that led to the final catastrophe. Wilhelm Hoffmann, in his book, *After the Catastrophe*[8], contributes something to the solution of the problem of guilt by characterizing the various classes of the people and their attitude toward the war. "There was no common enjoyment", he says. "The soldier was separated from the people. 'It is not our war' was definitely the feeling of the population".

The octogenarian Professor Fried-

(please turn to page 52)

(continued from page 50)
rich Meinecke interprets the recent events in his book, *The German Catastrophe*[9], from a far more scholarly viewpoint. He traces the two great ideals which have motivated the German political community during the last two centuries—nationalism and socialism. In addition, his contributions are of importance in dealing with the question of guilt; he emphasizes fate, which has played such a stunning role in German history. Of course, it could be suspected that Germany's leading historian would like to make it easy for his nation by introducing the element of fate. It must, however, be stressed that he, like all the other aforementioned authors, is emphasizing the fact that he writes as a German to the Germans and not to foreigners to win their sympathy.

All of these authors speak of the guilt of Germany. Everywhere the desire to clarify and interpret past events is evident. But they do not stop there. In them all there burns the great question: Now what? There is a will one can sense—a very strong will, indeed—to continue from somewhere, and as a starting point for this new continuity, they all have chosen the same thing: Goethe's individuality. Exactly there, where the great abyss began — the abyss which formed two different camps, the one nationalistic and the other socialistic —they wish to start anew. This new way was almost systematically set forth by Professor Ernst Beutler in his magnificent little book, *The Reawakening*.[10]

In it he maintains that the German youth after Goethe did no want to know anymore about "thinking and wanting", but about "wanting" alone, "until at last in the streets of disaster we could hear that tragic sigh: 'we must not think about it,' which was the result of that spiritual attitude". The interpretation of Faust also ought to be changed, according to Beutler. Faust was never considered by Goethe as a model character, a hero, and the word "faustisch", often employed by the Germans for their own characterization, had never been used by Goethe himself. Faust always has been too much a man of mere wishing, not wishing and thinking. He ought to become a warning to the German nation rather than its model hero.

In addition to those works which attempt to report events and those which try to interpret them, there is now appearing a still modest but important group of books which tries to pour recent experiences into some literary form. We can divide such works into those which merely report events in some literary form and those which go beyond and try to come to some solution.

The quite well-known *The Good Rights*[11], by Edschmidt, reports events in the form of a novel. It deals with the worries of a German author during the last years of the war. There also has recently appeared a book of poems, *Gedichte*[12], by young Erich Sanders, who writes, prays, complains, and warns. But he makes no attempt to interpret or to arrive at
(please turn to page 54)

(continued from page 52)
some answer.

Ernst Wiechert seems to be the only one thus far who goes beyond literary report into the realm of striving for clarification, if not solution. In his *Requiem*[13] he recalls the hopeless situation of the Hitler years, and he expresses his belief that life can be mastered only by those who can take on sufferings with kind and willing hearts. All classes of the German nation were affected by their cruel rulers; only the others won the struggle, since they had taken on the burden with pure and willing hearts. "We did not bear hate, we did not bear anger, we bore only love and the seed and the fruit." Perhaps the very widely known *Stalingrad*, by Plivier[14], should be grouped here, too, but its "solution" seems to be merely an exaggerated presentation of the event which brought forth the great success of that book.

Though still very small, of course, perhaps the most important group of literature is pure literature, or belles-lettres—works uninfluenced by recent events. Probably no such writing is possible in present-day Germany, or even in present-day Europe, because recent political events determine or influence almost any artistic creation, and they especially influence writing. I refer here merely to those works in which the events of the last few years are not used as a motif, milieu, or as background philosophy. Such independent books exist only in a small number. Even as great a woman as Ricarda Huch not yet has been able to create any important work which escapes the influence of recent experiences, although even long ago she had tried to isolate herself from this possibility by escaping into past centuries. Hans Carossa, also, is still too bewildered to be strong enough to create a purely literary work. In order to re-orient himself, he is writing his life story at present.

Werner Bergengruen, author of the famous *Tyran,* seems to be more successful because of his interest in the Catholic Church and the Middle Ages, and his recent works are pure creations of literary art. *The Three Falcons*[15] is a novelette unspoiled by references to the events of the last decade. The only writer other than Bergengruen who seems to be continuing his work logically without being paralyzed too completely by the last 15 years is Ernst Wiechert. It is a little harder for him, since his novels take place in the Germany of about 1900 and later. Shortly after the end of hostilities, his *Children of Jeromin*[16], a book without political tendencies and a piece of purest art, was published in Munich. It is a work of reflection, rumination, and concentration.

Almost all motives of his former great novels are being used again; they are, however, not merely repeated, but are combined in various ways to achieve something new. This last novel of Wiechert's ends as all recent works of this author, by praising the daily labor through which a man obtains endurance and ability to suffer. It contains, as does no previous work by the same poet, many references to Goethe, whose influence can also be seen in the recent works of Bergengruen, Carossa, and many others. Similes, symbols and motives are borrowed from that great German master.

Thus, through the works of Wiechert and other authors, it becomes
(please turn to page 56)

Conference . . .

(Continued from page 27)

- (d) "A Null Method for Determination of Impedance in the 100-400 mc. Range" by J. F. Byrne, Airborne Instruments Lab., Inc.
- (e) "New Cathode-Ray Oscillographs and Applications" by C. Berkley, A. B. DuMont Labs., Inc.

19. FM BROADCAST DEVELOPMENTS
    - (a) "A 50 kw. FM Broadcast Transmitter" by C. J. Starner, Radio Corporation of America
    - (b) "A Pulse-Counter Type FM Station Monitor" by David Packard and N. B. Schrock, Hewlett-Packard Co.
    - (c) "Transatlantic FM Transmission" by L. B. Arguimbau and J. Granlund, Massachusetts Institute of Technology
    - (d) "Phase Modulation Circuit" by S. M. Beleskas, Radio Corporation of America
20. ELECTRONIC CIRCUIT ANALYSIS II
    - (a) "Analysis of Oscillator Frequency Instability" by F. P. Fischer, University of Connecticut
    - (b) "Transient Behavior in Non-Linear Systems" by C. S. Roys, Syracuse University
    - (c) "Calculation of Operating Characteristics of Electromagnetic Devices" by R. M. Soria, American Phenolic Co., and T. J. Higgins, Illinois Institute of Technology

(continued from page 54)

abundantly clear that present-day publications in German-speaking countries reach back to established works, particularly to those of Goethe.

There has been, until now, no general investigation of the subject of recent German publications, with the exception of an article by Thomas Mann's son, Klaus Mann. In his article Mann states that present-day literary Germany is nothing but a vacuum in which a few old forces are still lingering but gradually waning: Ricarda Huch, who is too old to go on with her work; Ernst Jünger, who worked for National Socialism; Walter von Molo, who does not count; Herman Hesse, who has become a Swiss citizen. Wiechert is "all right," Mann says, but not good enough. Mann feels that Wiechert is too foggy and too teutonic, that he is a nationalist and a mystic, and that he is terribly vain (this from Klaus Mann!). Hence, a vacuum, Klaus Mann believes, which could be filled artificially by importing literature by the refugees (Mann, Werfel, etc.). This possibility, unfortunately, is too limited by military government regulations.

To me, the situation appears different. It reminds me of Stefan George's verses in his *New Reich,* in which he almost prophetically tells about the tortured lute player who destroyed his instrument because he could not equal his admired partner, and who in his knowledge of his own insufficiency turned disciple and herald of the greater one whose heights he could not reach:

"Heb mich auf deine Höh
Gipfel—doch sturze mich nicht!

Nur was im schutzenden Schlaf
Wo noch kein Taster es spurt
Lang in tiefinnerstem Schacht
Weihlicher Erde noch ruht—
Wunder undeutbar fur heut
Geschick wird des kommenden
Tages".

Bibliography

1. Walter Widmer, *Tristan und Isolde*, Classen Verlag, Zürich, 1946.
2. *Trostliche Dichtung, Vom Dauernden in der Zeit*, Werner Classen Verlag, Zürich.
3. Ulrich von Hassell, *Vom Andren Deutschland*, Atlantis Verlag, Zürich, 1946.
4. Fabian von Schlabrendorff, *Offiziere gegen Hitler*, Europa Verlag, Zurich, 1946.
5. Ernst Wiechert, *Der Totenwald*, Rascher Verlag, Zürich, 1946; in English: *Forest of the Dead,* Greenberg Publishers, New York, 1947.
6. Julius Ebbinghaus, *Zu Deutschlands Schicksalswende*, Vittoria Klostermann Verlag, Frankfurt a. M., 1946.
7. Karl Jasper. *Die Schuldfrage, Artemis* Verlag, Zürich, 1946.
8. Wilhelm Hoffmann, *Nach der Katatrophe,* Rainer Wunderlich Verlag, Tübingen, 1946.
9. Friedrick Meinecke, *Die Deutsche Katastrophe,* E. Brockhaus Verlag, Wiesbaden, 1946.
10. Ernst Beutler, *Besinnung*, Dieterichsche Verlagsbunchhandlung, Wiesbaden, 1946.
11. Kasimir Edschmidt, *Das gute Recht*, Keppler Verlag, Baden, 1946.
12. Erich Sanders, *Gedichte*, Privatdruck 1946.
13. Ernst Wiechert, *Totenmesse*, Rascher Verlag, Zürich, 1946.
14. Theodor Plivier, *Stalingrad*, Verlag, 1946.
15. Werner Bergengruen, *Die Frei Falken*, Verlag dor Arche, München, 1945.
16. Ernst Wiechert, *Die Jeromin-Kinder*, Zinnen-Verlag, München, 1945.
17. Klaus Mann, *The Literary Scene in Germany in Tomorrow*, March, 1947.

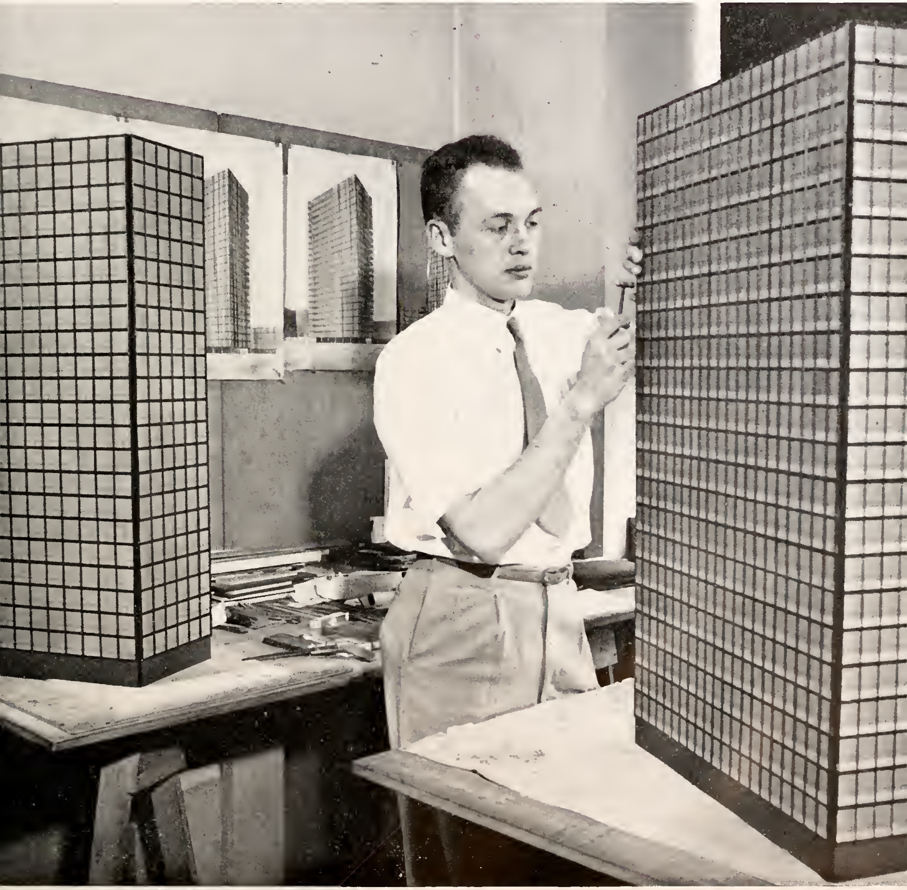
Contributors . . .

(continued from page 4)

Elmore Shaw Pettyjohn is the director of the Institute of Gas Technology, an affiliate of Illinois Tech. He received his B.A., B.S.E., and M.S.E. degrees at the University of Michigan. In addition to several years of industrial experience as consultant to numerous gas companies, Mr. Pettyjohn completed research projects on the use of bituminous cokes, evaporation, and heat transfer. He was an associate professor of chemical engineering at the University of Michigan when he joined the United States Navy in 1940. Mr. Pettyjohn was promoted to the rank of captain shortly before he returned to civilian life in 1945. He accepted his present post in April, 1945.

Friedrick K. Richter, associate professor of foreign language and literature at Illinois Tech, spent his early life in Germany and received the degree of doctor of philosophy at Breslau university, Bonn, Germany. Dr. Richter came to this country in 1937 and in 1941 joined the Illinois Tech staff. He is also a painter, and a number of his works have been exhibited in the United States and Europe. He has worked in the field of race relations, and in 1944 he received the distinguished interracial cooperation service award. At one time Dr. Richter served as assistant editor of *ETC.: A Review of General Semantics.*

ILLINOIS TECH ENGINEER



DECEMBER, 1947

A Merry Christmas

FOR EVERY SMOKER

CAMEL
CIGARETTES

A carton of Camels will bring a happy Yuletide smile to any cigarette smoker on your list. These cartons come all dressed up in a strikingly handsome Christmas design with a "gift card" right on top. Remember: More people are smoking Camels than ever before!

R. J. Reynolds Tobacco Company, Winston-Salem, North Carolina

PRINCE ALBERT
SMOKING TOBACCO

Prince Albert Smoking Tobacco — for pipes or roll-your-own cigarettes — is America's biggest-selling tobacco. Smokers know it as the National Joy Smoke because it's so rich tasting, so mild and easy on the tongue. You'll enjoy giving Prince Albert—in the colorful Christmas-wrapped one-pound tin.

VOLUME 13 NUMBER 2 DECEMBER, 1947

ILLINOIS TECH ENGINEER

In this issue

Published October, December, March and May.
Subscription rates, $1.50 per year.
Editorial and Business Office, Illinois Institute of Technology,
3300 Federal St., Chicago 16, Illinois.

Contributors . . .

John T. Rettaliata is professor and director of the department of mechanical engineering at Illinois Tech. He received his bachelor's degree in 1932 and his doctorate in 1936, both at Johns Hopkins university. He taught mathematics and engineering at Baltimore College Center while engaged in his graduate study. In 1936 he took charge of the calculation and development division of Allis-Chalmers steam turbine department, and later was appointed manager of the research and gas turbine division. In 1941 he was awarded the junior award of the American Society of Mechanical Engineers for his paper on the "Combustion Gas Turbine" and in 1942 he received the Pi Tau Sigma Gold Medal Award for outstanding achievement in mechanical engineering. During the war he traveled to Europe on two special missions, involving jet propulsion aircraft and enemy technical developments, for the United States government. He joined the Illinois Tech staff in 1945. He has published numerous papers in his field.

Linton E. Grinter, research professor of civil engineering and mechanics at Illinois Tech, has published five books on structural analysis and design and has written numerous articles on indeterminate structures. His essays, "The Education of Engineers for Latin America" and "When Will Skyscrapers Rise Again" appeared in the March, 1947, and October, 1947, issues of this magazine, respectively. A short biographical sketch of Dr. Grinter can be found in the October, 1947, issue.

Benjamin Lease is instructor in English at Illinois Tech. After receiving his bachelor's degree at Indiana university in 1939, Mr. Lease did publicity and newspaper work in Wisconsin for several years. He entered the University of Chicago for graduate study in 1942 and received his master's degree the following

(Please turn to page 4)

COVER PICTURE—Sharpe S. Stanfield, graduate student in architecture, works on skyscraper models in the architecture laboratory.

(Continued from page 3)

year. He taught humanities and English at the University of Chicago for three years before joining the staff of Illinois Tech in 1946.

Henry T. Heald is president of Illinois Institute of Technology, Armour Research Foundation of Illinois Institute of Technology, and the Institute of Gas Technology. He received his bachelor's degree in engineering at the age of 18 at Washington State college and two years later, in 1925, was awarded his master's at the University of Illinois. From 1925 to 1927 he was a practicing engineer in Pullman, Wash., and in Chicago. He joined the staff of Armour Institute of Technology as assistant professor of civil engineering in 1927. In 1931 he became an associate professor and in 1934 he was made professor. Dr. Heald became acting president of Armour Tech in October, 1937, and seven months later he was named president. He became president of Illinois Tech in July, 1940, when Armour Tech and Lewis Institute merged to form the present institute. In 1940 the National Junior Association of Commerce named him one of the "Ten Outstanding Young Men in America" and in the same year he won the distinguished service awards of both the Chicago and Illinois Junior Association of Commerce. He received an honorary doctor of engineering degree from Rose Polytechnic Institute and an honorary doctor of laws degree from Northwestern university in 1942. He served in numerous capacities during the war, and in 1945 won the Navy Award for Distinguished Civilian Service. Dr. Heald also engages extensively in civic work.

James W. Armsey, director of public relations at Illinois Tech, obtained his bachelor's degree in journalism and his master's in political science, both at the University of Illinois. During the war, he was an Army public relations officer in Washington, D. C., Camp Kohler, Calif., Fort Douglas, Utah, and the India-Burma theater. In India, he was assistant PRO of the theater.

(Please turn to page 54)

Gas Turbines and Jet Propulsion

by JOHN T. RETTALIATA*

AT THE PRESENT TIME, the combustion type of gas turbine is receiving much publicity both in the United States and abroad. Such recent attention may cause it to be erroneously considered as an invention of modern times, whereas, in reality, the first patents were taken out for one during the latter part of the eighteenth century. Even at that early date inventors appreciated the advantages of a prime mover with purely rotary motion and, also, of one devoid of the complexities existing in a steam plant. With a background of so many years, it is natural to inquire why the cycle has not found practical application before now.

In the early days, the main difficulties with the gas turbine were the lack of available materials to withstand the high temperatures needed to produce good overall thermal efficiency and a compressor of adequate efficiency that would make the cycle feasible. Only in recent years have these two obstacles been overcome: today's better materials enable elevated temperatures, up to 1600 F in the case of aircraft gas turbine supercharges, to be used; and an axial compressor, upon which years of aerodynamical research have been spent, affords the necessary high-efficiency compressor element.

The subject of gas turbines is exceptionally comprehensive and space will limit the scope of this paper. The first part of the paper will deal with design features of construction of a modern combustion type of gas turbine, the second with cycle performance characteristics, and the third with some suitable applications, including, in particular, jet propulsion.

Design features

A gas turbine operating on the basic cycle is shown in Fig. 1. The gas turbine at the left is connected to an axial compressor in the center which, in turn, is connected to a generator on the right. Air from the atmosphere enters the intake of the compressor, and traverses the axial flow blading where it is compressed to a pressure of approximately 45 psig. It leaves the compressor and part of it flows to the internal part of the fuel burner where it is used for combustion purposes. The remaining and larger portion flows through the annular space between the inner and outer burner shells and then mixes with the products of combustion, cooling them to a satisfactory turbine inlet temperature. The heated gases then pass through the turbine and are exhausted to atmosphere. The power required by the compressor is less than that developed by the turbine so the excess is furnished to the generator. The unit is started by means of the starting device shown at the left.

A partially completed gas turbine, in course of shop erection, is shown in Fig. 2. The axial compressor is shown at the right directly coupled, through the solid coupling, to the reaction type of gas turbine shown on the left. Air from the atmosphere enters at the center, flows to the right through the compressor, and is discharged at the high pressure and to a combustion chamber, not shown in this view. Heated gases from the chamber then enter the turbine through the passage shown at the left, pass through the turbine and are discharged to atmosphere.

The majority of the gas turbines built by Allis-Chalmers to date have been used in the Houdry catalytic cracking process in the manufacture of high octane gasoline. In this particular application the oil refinery is interested in obtaining large volumes of compressed air to reactivate a catalyst in the process. Accordingly, no combustion chambers are used on this type of gas turbine as the process

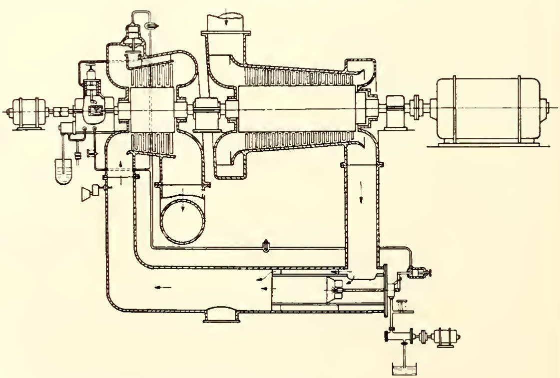


Fig. 1. The gas turbine axial blower unit.

* Professor and director, department of mechanical engineering, Illinois Institute of Technology. This article is a condensation of a paper presented by Dr. Rettaliata before the American Institute of Electrical Engineers in Mexico City, Mexico, August 28, 1947.

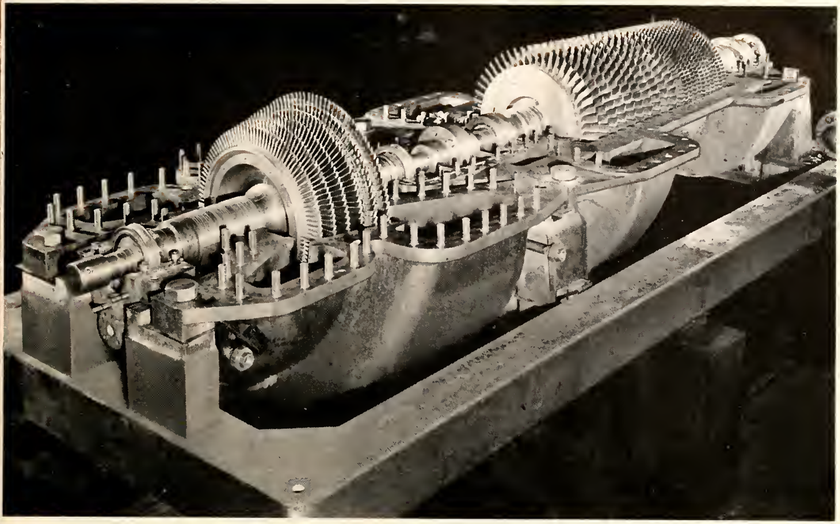


Fig. 2. A 23,000 cfm gas turbine axial blower unit with the top half of the casing removed.

itself acts in this capacity. The unit of Fig. 2 is one of the Houdry turbines. It is rated in accordance with its compressor capacity which is 23,000 cfm, referred to standard conditions at the compressor intake.

The turbine blades, of unit construction, are milled from solid stainless steel bar stock so that the highly desirable integral roots result. Lacing wires are inserted in the spindle blades for stiffening purposes, in order to reduce bending stresses and increase the natural frequency of the blades.

The axial flow cylinder and spindle compressor blading has separate spacer pieces, and the blades are held in place by their alternate insertion with spacers in grooves in the casing and spindle. In order to approach the ultimate in efficiency the blades have airfoil sections, and the change in momentum of the motive fluid per stage is less than in the turbine.

In the fuel oil burner element, some of the air discharged from the compressor enters the louvers and passes to the internal portion, furnishing air for combustion of the fuel. The remaining and larger portion of the air flows through the annular space defined by the outer surface of the burner shell and the internal surface of the combustion chamber. This air is given a whirl by means of deflectors, which causes it to be more intimately mixed with the products of combustion leaving the central passage. The louvers adjusting the amount of air entering the internal portion are regulated by means of an external lever.

Performance characteristics

The performance characteristics of a gas turbine are determined principally by the maximum temperature of the cycle, the ratio of the maximum and minimum pressures existing simultaneously and the nature of the components comprising the cycle. There are a multitude of possible cycle arrangements, and the adoption of a particular cycle is influenced by the type of application involved.

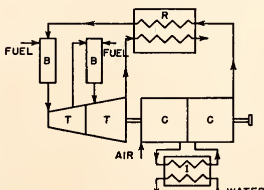


Fig. 3. The regenerative cycle with reheating and intercooling.

If it is desired to improve thermal efficiency, a regenerative cycle may be employed, wherein the turbine exhaust gas, before discharging to the atmosphere, is used in a heat exchanger to preheat the compressor discharge air prior to the entry of the latter into the combustion chamber.

Further increases in thermal efficiency may be achieved by adopting a reheat feature where, before it reaches the exhaust pressure, the expanding motive fluid in the turbine is withdrawn at an intermediate point and reheated, usually to the same temperature which it possessed at the turbine inlet. After the reheating operation, the high temperature gas then re-enters the turbine and continues its expansion to the exhaust pressure. Reheating increases the positive work of the cycle by increasing the amount of energy liberated by the expansion of a given quantity of

gas through a prescribed pressure ratio.

Improvements over the straight regenerative cycle may also be realized by employing intercooling in the compressor. This operation may be considered as the reverse of turbine reheat, in that air is extracted at an intermediate point in the compression process and cooled in a heat exchanger. The coolant is usually water. The air leaving the intercooler at reduced temperature and volume is introduced into the high-pressure side of the compressor and compressed to the final pressure. The intercooling feature reduces the negative work of the cycle by decreasing the amount of energy required to compress a given quantity of air through a stipulated pressure ratio.

As may be expected, thermal efficiency may be enhanced still further by a combination cycle, Fig. 3, comprising all of the features listed in the paragraphs above. It should be understood that the foregoing cycle analyses are by no means exhaustive, for

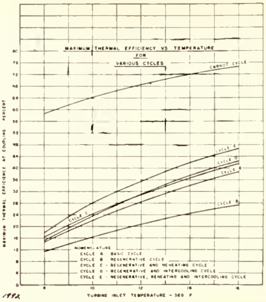


Fig. 4. The effect of temperature upon the maximum thermal efficiency of the various cycles.

the number of conceivable cycle arrangements is literally limitless. However, regardless of the cycle adopted, it should contain some or all of the components previously discussed. These are representative of elements which have been used in existing cycles.

The thermal efficiency of a cycle at a given turbine inlet temperature will vary with pressure ratio, attaining a maximum at a particular value of the latter. So that a comparison of the various cycles can be made, their maximum efficiencies as a function of temperature are plotted in Fig. 4. The effect of elevated temperatures on increasing thermal efficiency is evident. Because of the improvements associated with the use of higher temperatures, real incentives exist for metallurgical advances in developing alloys suitable for operation in the upper temperature regions.

In Fig. 4, the performance data are based on a turbine efficiency of 86 percent, a compressor efficiency of 84 percent, a combustion efficiency of 98 percent, a compressor intake temperature of 60 F, and mechanical losses of 0.5 percent in the turbine and also in the compressor. In the cycles employing regeneration, the heat exchanger surface is 5 sq ft per coupling hp, and the overall heat transfer coefficient from gas-to-air is 10 Btu per

(Please turn to page 22)

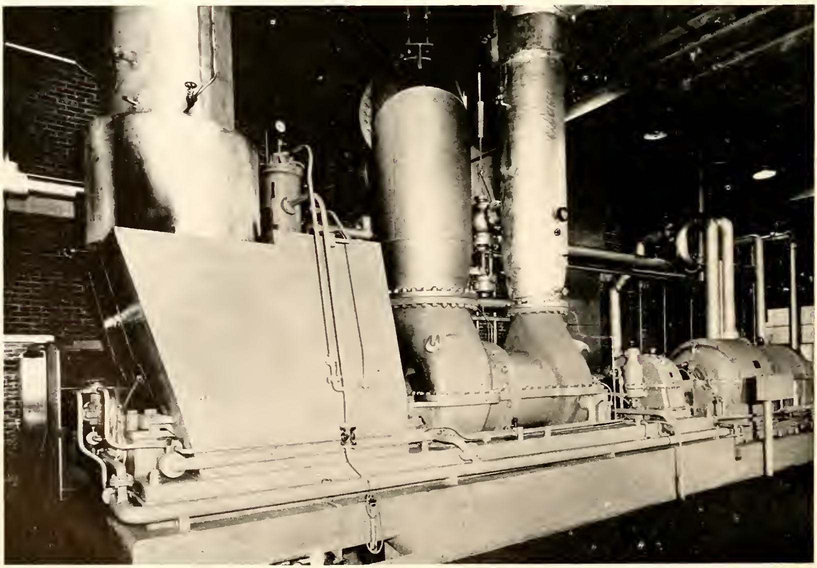


Fig. 5 A 60,000 cfm axial compressor gas turbine unit, the largest in the world.

Relative Values In European and American Systems of Engineering Education

By LINTON E. GRINTER*

IT MAY appear strange for an American who has never studied in a European university to attempt to compare the results of engineering educational procedures used on the two continents. However, American engineering educators have had an unusual opportunity during the decade of the dictators to observe the strengths and the weaknesses of European educational methods through the medium of those students who have come to the United States to complete their undergraduate education or to enter our graduate schools.

We therefore may be able to offer a critical comparison of the relative values of these two systems of engineering education. European teachers have had an even better opportunity to observe American teaching methods by their appointments as teachers in our colleges. It becomes clearer each year that their criticisms and suggestions have gradually been reshaping the American pattern of higher education. Such interchange of ideas and of criticism always results in improvements.

In the limited field of engineering education it is perhaps safe to compare European and American educational objectives without considering the many variations that exist in the two hundred institutions involved. It seems fair to say that European procedures at the university level have had as an objective the education of exceptional students. It also seems fair to say that American universities have directed their principal attention toward the average student.

The result is that Europe has hand-polished a limited number, or, in fact, a small number of engineering scientists, while America has mass-produced a large number of practical engineers. Fortunately, both continents have had some schools which countered the basic trend, but the emphasis has been as indicated.

It is only necessary to note that about 225,000 baccalaureate students were enrolled in the engineering colleges of the United States in the fall of 1946, while perhaps no more than 5,000 were similarly enrolled in England, to understand the results of this great difference in educational philosophy. It is also possible to evaluate the results in terms of differences in industrial production.

The older continent has surpassed in fine workmanship; the newer in volume production. We now realize that America has depended to an unwise extent upon scientific ideas from Europe while Europe has, with equal lack of vision, been slow to accept the American invention of mass production. Each must adopt certain features of the educational plan of the other if each is to progress as it should.

In the United States there is great need for deeper educational opportunities for exceptional engineering students. The principal weakness of our educational program in the universities stems from the philosophy of mass education at the high school level.

Since public education must consider the average student rather than the exceptional student, our university system of education has naturally granted opportunities to the resulting large numbers of high school graduates. Such numbers preclude the possibility of special attention to the unique educational problems of the exceptional student.

It remains for those colleges of engineering under private control to lead the way in providing exceptional students with a more scientific education in the engineering field—an education leading to a career in research and the scientific phases of design, or in teaching. We have the graduate schools where such studies may be conducted at the post-graduate level, but it is equally important that there be early stimulation of the gifted student in his undergraduate program.

It is self-evident that our present group of 225,000 engineering students cannot all be profitably trained for the more scientific accomplishments. Hence, two paths of engineering education will be required in place of the single path or curriculum that exists in America today.

* Research professor of civil engineering and mechanics, Illinois Institute of Technology. This article was prepared for presentation at the International Congress for Engineering Education at Darmstadt, Germany, by invitation from the Rector of the Technische Hochschule Darmstardt, Professor Dr. Richard Vieweg, and was delivered in absentia, August 6, 1947.

In Europe students have always been treated as mature individuals who were expected to understand the necessity for unguided study. Exceptional students react favorably to such instruction, but more direct guidance is necessary for students of average ability. We know this to be true because European teachers in America have not, in general, obtained good results in their first years of teaching American students.

After a period of experience in an American university, the European teacher learns to assign problems to be turned in for grading and otherwise to set tasks essential to the understanding of the subject which those students who are not exceptional will perform.

If Europe is to reconstruct itself and rebuild its leadership of the past, it will be forced to train engineers in much larger numbers than heretofore. The scientific developments of the war years, and those that are now reaching the production stage in industry, require large numbers of scientists, engineers and technicians for construction, production and maintenance, in addition to those needed for research and design.

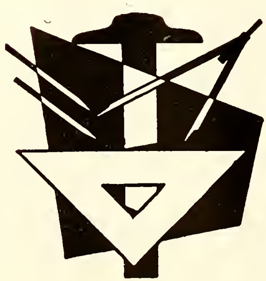
We realize that Europe has not depended upon schools of engineering for all of its technical personnel. Fortunately there have been more and better technician training schools in Europe than in America; also, apprenticeship training has been effective. However, there are jobs for a much larger number of real engineers than can ever be supplied from the limited number of young men (and women) who are in the exceptional group. And it seems doubtful that technicians trained in a two-year or three-year period can serve as adequate substitutes.

Our experience with shortened periods of training during the war years does not recommend that that procedure become universal. In our opinion, in America a rather large number of young men of only average ability (for university students) are needed with full four-year engineering training. Apparently it will require considerable change in the program of European higher education before this need can be fulfilled.

As a contribution to the usefulness of young engineers who are expected to hold positions in construction, production, operation and maintenance, rather than research and the higher phases of design, European institutions will need to place greater emphasis upon laboratory and practical design courses. We have observed that European students who come to America are commonly proficient in the use of mathematics but deficient in the skill of handling laboratory equipment.

If this interest in the theoretical side of engineering education is as common to those students who remain in Europe as to those who have migrated to America, it is clear that there must be dark bands in the spectrum of European education corresponding to the fields of laboratory and pilot plant experimentation and practical design studies. It will therefore be necessary to expand laboratory facilities and, of course, to modernize all educational laboratories in step with recent technological advances. Much equipment in American institutions is far from modern, but when revised to demonstrate modern usages, it remains serviceable.

The writer's visit to European educational institutions in 1946 confirmed the natural assumption that European education, like American education, is due to undergo major changes in the reconstruction period. Everywhere our youth are demanding the opportunity of higher education, and nothing is more certain than that youth, in this regard, will have to be served.



In England the question of whether Cambridge and Oxford Universities should accept larger numbers of students was reaching the stage of national discussion in the summer of 1946. The mere fact that the matter was on the front page of London newspapers for several days is an indication that the issue was considered no minor one.

It is at least fortunate that the demand of youth for a university education in the technical field coincides with the cry of industry for more and more engineers. Perhaps we shall prove again the experience of past decades that more engineers always produce more jobs for engineers.

Is it not possible that the number of persons of engineering training that can be used economically by industry may eventually reach or perhaps exceed the number of persons whose interests and abilities make them proper recipients of education in this field?

It has seemed clear for some years that we are never likely to stimulate as many persons to surmount the difficulties involved in achieving the level of the doctorate in engineering as industry and education would desire. Perhaps we shall find that the same situation exists at the level of the first baccalaureate degree in the engineering field.

It would be comforting to know that our visions of overproduction of engineers were merely phantoms. At least in Europe, there can be no probability of overproduction of engineers until reconstruction and the natural expansion occasioned by adoption of new technical ideas has reached its peak a decade from now. If national economics can match technical accomplishments, no waning of industrial activity need occur.

When we consider the engineering aptitudes of mathematical ability, visual perspective, a practical sense of values and capacity for making decisions, it seems clear that the world as a whole is not likely soon to be over supplied with engineering leaders, nor perhaps with those who follow these leaders.

JOHN NEAL: YANKEE EXTRAORDINARY

by BENJAMIN LEASE*

A GENIUS IS RARELY understood or appreciated until he has stopped being one; in due time, people start hunting for his grave and erect a monument at the most likely spot. A genius has only himself to blame, for he is, by nature, too far ahead of the present to be there when the future discovers him. His message is not for his own time but for all time; and his contemporaries are like the customers in the front row at the movies: too close to get a good look.

This is to say that the history of a people is not the same as the history of great men. Certainly, the genius has his roots in his own time, but the student of history is likely—and understandably so — to be diverted by the infinite spreading branches. The historian may frequently learn more about what the past is like from lesser men, from men who have not survived their own times. Hawthorne and Emerson and Whitman and Melville and Thoreau were closer to profound and electrical ideas than to the men about them. They observed the world in which they lived but they saw with the transforming eyes of the seer. The diary of a day-laborer of the 1840's would be far more valuable to the American social historian than all the journals of Emerson.

This is not to say that the history of a people is the same as a history of mediocre men. Many extraordinary men are forgotten shortly after the last obituary is filed. They are forgotten because their contributions, startling and influential though they may be, are primarily timely rather than timeless.

Such a man was John Neal. There is probably no more remarkable and colorful figure in the history of American letters. His life span—extending from 1793 to 1876—roughly parallels the first century of America's existence as a political entity. (Shortly before his death he negotiated for the publication of a "centennial" edition of his early novel of the Revolution, *Seventy-Six.*)

He was not a genius; but more than the giants of the American literary renaissance, Neal embodied many of the transitional traits of the young Republic: strident assertiveness, tremendous energy, dogged courage and honesty, self-conscious national pride, excessive impatience with tradition and any new discipline necessary to take its place.

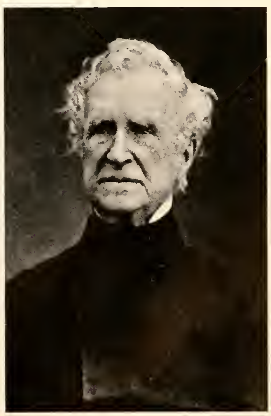
Self-reliance was his birthright. His father, a Quaker schoolmaster in the district of Maine, died when John and his twin sister were a month old. His mother thereupon opened a private school and supported her family to the best of her ability. Neal's formal schooling was over when he was twelve. During the next decade he ran the gauntlet through a number of jobs from shopkeeper's apprentice to itinerant portrait artist. If audacity, versatility and shrewdness are the identifying marks of the Yankee character, Neal was its walking embodiment. As a dry-goods clerk he learned about the shrewdness of the Yankee trader:

"It was an established principle with us, no matter what was wanted, always to show the poorest first, thereby enhancing the best by comparison; to keep the windows and doorways so dark, partly by hanging shawls and other showy goods both inside and out, and partly by painting the back windows, that people were often astonished at their bargains, after they had got back to their houses; not only the quality, but the very color of their purchases, undergoing a change for the worse."

Too restless to stay long in one place, Neal gave up clerking and became, in turn, a writing master, a schoolmaster, and a portrait sketcher. During the War of 1812 he was actively and profitably engaged in a variety of speculative ventures up and down the coast from Boston to Baltimore. Toward the end of the war, Neal entered into a partnership in Baltimore with John Pierpont. The post-war recession wiped out their business.

It was the turning point in Neal's life. At twenty-three, penniless, and with less than a grammar school education, Neal determined to study law in a city noted for distinguished lawyers and rigorous bar requirements. And to finance his studies, he determined to do that which no American writer had hitherto succeeded in doing—earn his living by his pen: No one audacious enough to embark upon such a venture could possibly fail.

Neal was encouraged in his literary efforts by his membership in the Delphian Club, a genteel literary society. He promptly displayed a fund of crude and inexhaustible energy that



A rare, previously-unpublished photograph of John Neal.

---

* Instructor in English, Illinois Institute of Technology.

THE undersigned, (1) having entered into some correspondence with the reputed author of "Randolph;" who is, or is not, (2) sufficiently described as JOHN NEAL, a gentleman by indulgent courtesy;—informs honourable men, that he has found him unpossessed (3) of courage to make satisfaction for the insolence of his folly. (4)

Stating thus much, the undersigned commits this Craven (5) to his infamy. (6)

EDWARD C. PINKNEY.

Baltimore, Oct. 11, 1823.

(1) The *undersigned*—quite *diplomatick*. (2) That is—I have challenged John Neal, who *is*, or is *not*, the author of Randolph—because he *is*. (3) Beautifully expressed. How much *more* beautiful, and cautious, than to say—I found him *without* courage, or *destitute* of courage. (4) To be read either way—"insolence of his folly"—or "folly of his insolence." (5) Craven—Blackstone. The young gentleman has read law, to great advantage. (6) Awful, to be sure—what will become of poor Mr. Neal, after that dooming; or *consignment*, rather.—ED.

A facsimile of the handbill in which Edward Pinkney charges Neal with cowardice. Neal added the comments beneath and published the handbill as an appendix to his novel Errata (1823).

amazed and almost terrified the refined Delphians. Between 1816 and 1823, Neal poured forth five novels[1] (each in two volumes); a book of poetry; a five-act tragedy; hundreds of articles for the magazines and newspapers; and two huge literary hack-jobs: he collaborated in the ghost-writing of Allen's History of the American Revolution, and compiled a *General Index to the First Twelve Volumes of Niles' Weekly Register*. And by 1823, he had secured admission to the Maryland bar and established a flourishing practice.

Naturalness and originality

In all of Neal's criticism, his central dictum was: Be Yourself! At a time when most American writers were well-mannered and imitative, Neal stormed for naturalness and originality. His ultra-nationalism was no bumptious chauvinism but a logical extension of this central concern. A great literature could be achieved only when writers rejected literary models and followed the dictates of their own observations and emotions. Neal exhorted writers to observe those objects which move us in nature, to note how vastly different they were from the ordinary productions of authors:

"Nature is direct.—Her eloquence is of the blood—the crowded sky—the thought breaks upon you, clap after clap, till your whole nature is disordered. Call up a mother, who has just lost her infant—bid her tell her story—look at her—study her. There is no wearying preparation. She repeats the same thing, over and over again, a hundred times.—There is no poetry; no play of the imagination, in what she says. There is not even the simplest observance of rule—her sentences are short—broken—exclamatory—familiar—colloquial—vulgar, it may be, and ungrammatical. But your tears follow—and your heart heaves to it. Can you improve it? Take it home—dress it up into an oration—dramatize it—and lo! the essence, that volatile and penetrating spirit, which, from the broken hearted mother, set all your arteries weeping, that has escaped!"

It was this vein of natural self-expression that Neal attempted in his novels. Many young people—including Longfellow and Hawthorne—were greatly captivated by the result. But many more were convinced that these formless, chaotic productions were the work of a madman. For, according to one critic, Neal's pen

"mingles with any thing and every thing. It preaches; it prays; it reviews; it criticizes; it travels and romances; it talks English, an Indian, and New-England yankee. It is now divine, anon a braggart; now in the wilderness, with savages and beasts, anon in churches and temples; now here, anon in Europe; ambitious everywhere, eccentric every where, full of furious and fiery emotions, without distinguishing time or place, or the fitness of things, or dignity of character."

It was inevitable that such free-talking, outspoken writing would get Neal into trouble. Neal incorporated into his novel, *Randolph*, an eight page caustic commentary on the statesman, William Pinkney; Pinkney retaliated by dying shortly before the book was published. But Neal, with characteristic stubborness, refused to alter his criticism, heaping coal upon the fire by stating his reasons in a footnote. Challenged to a duel by Pinkney's son, Neal, consistent with the anti-duelling views expressed in his first novel (*Keep Cool*), rejected the offer. He was promptly posted for cowardice. Thereupon, Neal, with his usual audacity, published his entire correspondence with Pinkney—including the hand-bill branding him a coward—as an appendix in his next novel, *Errata*.

[1]**Keep Cool** (1817); **Logan** (1822); **Seventy-Six** (1823); **Randolph** (1823); and **Errata** (1823).

RACHEL DYER:

A NORTH AMERICAN STORY.

BY JOHN NEAL.

PORTLAND:

PUBLISHED BY SHIRLEY AND HYDE.

1828.

The title page of John Neal's Rachel Dyer, **"the first novel to develop the tragic implications of the Salem witchcraft trials of 1692 as more than a background for sentimental romance".**

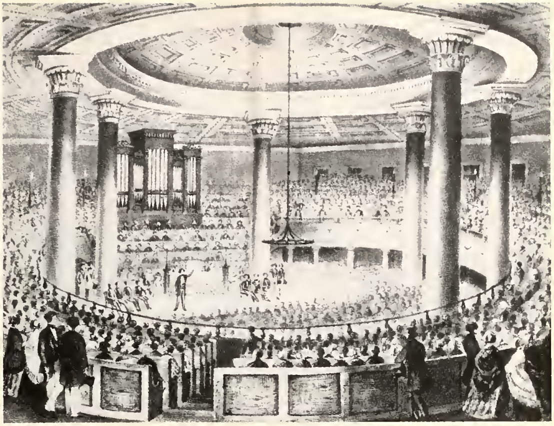
John Neal in England

Late in 1823, Neal left Baltimore for England to enter upon the most extraordinary chapter in an extraordinary career. His novels had created a flurry, and he was hopeful of extending his reputation over-seas. *Logan* and *Seventy-Six* had been republished in England and received favorable notices; Neal thought he could negotiate the republication of his other novels. And, in addition, Neal was determined to puncture the prevailing pompous attitude of cultered Britain toward American literature—an attitude epitomized by Sydney Smith's scornful query: "Who reads an American book?"

Neal's invasion of England was phenomenally successful. True, he failed in his republication venture and published only one new novel during his three and a half year visit. (The novel was *Brother Jonathan,* in three volumes totalling 1,322 pages; one British critic conjectured that its author must have employed "*both* his hands at the same time, one on one volume, and the other on the other.") But Neal did succeed in flooding the British magazines with aggressive articles defining American institutions, literature, and character.

His most amazing performance was a series of articles in Blackwood's Magazine which may be regarded as the first history of American literature. Writing in the guise of an Englishman, Neal presented in alphabetical sequence, commentaries on 137 American authors — including John Neal. In his criticism, Neal patronized neither his countrymen nor his hosts. He valued writers according to how they measured up to his central criterion: the character of the author, as reflected by his work. Bryant's temperament was too cool for poetry; Washington Irving lacked originality; Fenimore Cooper was too timid —his characters talk too well and are too much alike because, otherwise, the author might be charged with their crudity. Neal, on the other hand, according to Neal, was guilty of the more commendable evil of excess, or "prodigality":

"Neal is altogether too much of a poet. He overdoes everything—pumps the lightning into you, till HE is out of breath, and YOU, in a blaze.—In his lucid intervals, he appears to be a very sensible fellow; but, in his paroxysms—there is not a page of his, that wouldn't take fire, in a high wind. He writes volume after volume, to the tune of three or four a-month; hardly one of which it is possible to read through; and yet, we could hardly open at a passage, without finding some evidence of extraordinary power — prodigious energy — or acute thinking."



A view of the Broadway Tabernacle in New York where John Neal lectured on the "Rights of Women", January 24, 1843.

British customs and institutions did not escape Neal's caustic pen. Here are his observations, written after his return, on a first visit to hallowed Westminster Abbey:

"I saw too a crowd of people, with their hands in their pockets, running after a guide, all bare-headed and most of them with lips blue and teeth chattering — perhaps with awe —perhaps with cold. I saw moreover a marble countess on her way up to a marble sky—with a chair of state placed for her in the clouds, and a marble cherub, who occupied another chair, waiting for her to arrive. I saw men of a warlike shape armed cap-a-pie, with wigs on. I saw the figure of death, a skeleton such as we see in our picture-books, or in our sleep when we are naughty, issuing out of a marble safe with iron doors and aiming a sort of spear at a marble woman, which a marble man was upholding, if I do not mistake, with his right arm in the air. I saw a party of sober people, who had come to the show and paid their six pences a little too late, galloping after the guide, just near enough to be always a little too late for whatever he had to say; so that while he was describing the achievements of Edward the Black-Prince, they were looking at Queen Elizabeth; and all the notice he took of them was to order their hats off, 'by order of the Dean,' though we were shivering with cold, and they hot with exercise."

The return to Portland

Neal returned to his native Portland in 1827, opened a law-office, established a literary weekly, *The Yankee,* and gave lessons in fencing and sparring on the side. As editor and publisher, Neal encouraged the early literary efforts of Whittier, Dana, Hawthorne and Poe. He filled the magazine with his own contributions, the most notable of which was a series of articles on the theory of drama; in it, he called for a new, colloquial, domestic American drama in place of the versified, artificial, high-flown tragedies of the period.

He continued his campaign for natural eloquence in all of his writings—and they were voluminous and varied —to the end of his life, almost half a century later. In three novels between 1828 and 1833, he applied his critical principles with striking variation.

Rachel Dyer (1828) was the first

(Please turn to page 38)

Cooperation Between Industry and Education

by HENRY T. HEALD*

YOUR INDUSTRY WORKS in close cooperation with the universities and research laboratories of the nation; your equipment is in the forefront of scientific development. Because I think it will be of interest to you, I shall begin with a brief resume of the work of colleges and universities in this post-war period.

College enrollments increased steadily from less than 250,000 students in 1900 to nearly 1,500,000 students in 1940. In only one year — 1933, the middle of the depression, as you will recall—was there a decrease. Part of this increase resulted from the rapid growth in population. Even so, the percentage of youths in the 18-through-21 age bracket attending colleges rose from 4 per cent in 1900 to more than 15 per cent in 1940. Because of the war, enrollment dropped substantially after 1940. By autumn 1945, total college attendance was less than one million.

The end of the war brought a tremendous upswing. The flood of veterans reached the colleges by the fall of 1946, and enrollment soared to an all-time high of nearly 2,100,000. More than half were veterans. Total enrollment this fall promises to exceed last year's figure—perhaps by 15 per cent. Future college enrollment is a subject for all kinds of predictions.

The Veterans Administration reports that 40 per cent of all veterans have already applied for certificates of eligibility for education and training under the GI Bill of Rights. Undoubtedly, many will not be used; others will take on-the-job and vocational training. The U. S. Office of Education estimates that, in addition to the more than one million veterans enrolled in 1946, another one and two-thirds million eventually will seek education at the college level. Veterans have nine years after the end of the war, or after their discharge from service—whichever is later—to complete their education. For all but a small fraction, this means nine years from 1947.

Henry T. Heald

However, I believe that a high percentage of veterans who plan to attend institutions of higher learning on a full-time basis already have taken steps to begin. Indications are that the veterans' enrollment peak will be passed before 1950. This does not necessarily mean a decrease in total college population. If long-term trends continue—if educational facilities are readily available — and if economic factors do not interfere — college enrollments may well be maintained permanently at a figure in excess of three million.

To provide for the tremendous increase in students last year, colleges have had a difficult task. Institutions in almost every category have served more students than ever before. Classroom space, instructors, and living quarters have been inadequate in many cases. But on the whole, a pretty satisfactory job has been done. It has been made easier by the serious attitude of the veterans; they have given an excellent account of themselves. The veteran usually has done better work than the non-veteran student; he has demonstrated a sincerity, a staying power, and a capacity for work which augur well for the future of the nation; he has not developed some of the undesirable characteristics which a few college administrators predicted. Most of the expected problems of veterans' adjustments simply failed to occur.

Because of their war experience and because of war-time developments in science and technology, veterans in large numbers have selected engineering courses. Before the war, enrollment in engineering constituted about 6 per cent of the total. Today the figure exceeds 10 per cent. This increase promises to reduce, more rapidly than expected, the shortage of engineering personnel — a shortage caused by war-time interruptions in education. However, in my opinion, this increase does not presage any surplus of engineers and scientists in the foreseeable future. In our modern technological world, the percentage of engineers and scientists in our employed population inevitably will continue to rise.

Many persons believe that a large number of veterans were unable to enter college last year. Contrary to this popular opinion, there is no evidence that any substantial number of veterans — or high school graduates

* President, Illinois Institute of Technology; president, Armour Research Foundation of Illinois Institute of Technology; president, Institute of Gas Technology. This article is a condensation of Dr. Heald's speech before the Scientific Instrument Society of America, Chicago, September 8, 1947.

—were denied admission if they seriously sought to enter college and possessed reasonable qualifications. It is true that many could not enter the college of their choice. For example, many engineering students enrolled in junior colleges and emergency colleges whose curricula includes only the first two years of engineering work. Because of space limitations, these men are finding considerable difficulty transferring to the upper classes in other institutions.

Many colleges are somewhat more selective in admissions than in pre-war days. In so far as this insures education for the more able students, the trend seems desirable.

Freshmen who will enter college this fall are finding space more readily available than a year ago. At Illinois Institute of Technology, the freshman enrollment this year is 44 per cent veterans, compared with 63 per cent last year.

But despite the provisions for steadily increasing enrollments, there is no assurance that higher education is making its maximum contribution to the future of America. There are as many well-qualified young people who do not attend college as there are who do. Some of those who do not attend possess the potentialities for future leadership in science, in industry, in education, and in government.

I wonder if we can continue to afford this waste.

All veterans have been given an opportunity for an education for service already performed. Should we not be equally alert to see that our ablest youths have an opportunity for an education because of the service they will be able to perform? I refer, of course, to the problem of breaking down economic barriers in order that bright youth — whatever the condition of his parents' bank account — may not be denied the chance to develop his fullest potentialities. No geographical area, no economic class, no race or creed has any monopoly on intelligence. Equal opportunities should be available to all segments of society.

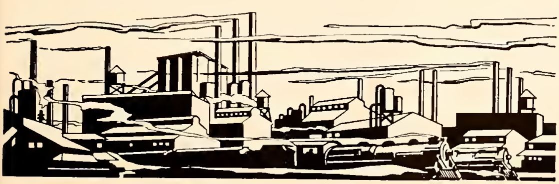
Support of American higher education traditionally has been the responsibility of the states and of private philanthropy. Both public and private universities have made important contributions to the education of the people; both are stronger because of their widely differing sources of support. In recent years, however, there has been a growing tendency to shift more of the responsibility for the support of college students—and, indeed, the universities themselves — to the Federal government.

I wonder if, by doing this, we are not taking the easy way. After all, Federal funds come from the people. The recent Congress demonstrated how difficult it is to reduce a bureaucracy once it is well-entrenched. Much of the same support now provided for education by the Federal government could be made available through independent action by individuals, corporations, and local taxing units. Such a procedure would place the responsibility where it logically belongs. And it would forestall the growing tendency toward bureaucratic control of higher education.

Industry, education, and government in research

President Truman, in a statement issued August 27 in conjunction with the release of his scientific advisory board's report, said:

"We must constantly enlarge the boundaries of scientific knowledge in order to continue to provide the benefits of full production and full employment, and in order to protect our democracy from the dangers it faces in an uneasy world."



I think most of us agree that the extension of scientific knowledge is a major factor in national survival. War-time experience demonstrated — with awe and foreboding — how much we could achieve in applied science in a short span of time — with strong motivation and adequate funds. Fortunately, many of the tools for applied research were already available in the form of fundamental knowledge developed in the research laboratories of universities, foundations, and industry. Private enterprise and our American system of education were equal to the emergency; and the freedom of inquiry so essential to scientific accomplishment bore fruit in the applications which assured our survival.

The scope of American research has expanded enormously in recent years, but in spite of this rapid advance, less than 15 per cent of all firms with more than $500,000 in gross annual sales are doing any research.

I do not think that I need to argue the case for industrial research. It is estimated that as much as half of the total employment in the United States today results directly from the production and distribution of products developed in research laboratories. Industrial research will continue to increase in the years ahead. But this increase hinges on two major factors, both of vital concern to universities:

1. The availability of an adequate number of qualified research workers. I am sure every man well qualified for research work is now employed. Yet personnel is insufficient. Nor will this deficiency be remedied rapidly. The modern research man needs six or seven years of college training; and the output of the universities, practically non-existent during the war, will not be adequate for years to come—even with expanded enrollments.

2. The growing need for the development of basic knowledge in all fields of science. Before the war,

(Please turn to page 42)

The new Chemistry Building (left background) and the Metallurgical and Chemical Engineering Building (right foreground) under construction. These buildings are now in partial use. They will be completely ready for occupancy in January.

Illinois Tech Builds

by JAMES W. ARMSEY*

SIX YEARS AGO, the trustees of Illinois Institute of Technology were confronted with a far-reaching decision.

Armour Institute of Technology and Lewis Institute, each with nearly half a century of service to education, had been consolidated to form the new Illinois Tech. A major immediate problem was the location of the new institution. Should it be developed at the site of one of the former schools? Or should it be built anew in other surroundings?

The Lewis campus encompassed an area too small to develop a college of the size envisioned by the trustees. The Armour campus offered more opportunity for expansion, but it had one extreme disadvantage. It had been established in one of the city's most desirable residential areas, but the passing years had seen its environs swallowed up by the largest contiguous slum area in any American city.

On the other hand, Armour's holdings on the near south side constituted a major investment in land, buildings, and equipment. Furthermore, the new college's service to the community rested in large measure upon a central location, readily accessible to the bulk of the population and close to the great industrial empire centered in Chicago.

Rather than flee from the encroaching blight, the trustees decided to stand and fight—to build a great midwestern technological institution and at the same time to take the lead in redeveloping the entire south side area.

Dr. Henry T. Heald, president of Illinois Tech, stated the case succinctly when he said:

"Chicago has 15,000 acres of blighted or near-blighted land. For the fourth largest city in the world, this is intolerable. If the citizens of Chicago do not act now, the malignant slum growth will shortly destroy the city's civic vitality. I consider slum clearance and rehabilitation the city's most pressing problem."

Illinois Tech had hardly come into existence before the physical development program got underway. The new modern campus — to be built over a period of years—would cover a 100-acre tract. But no sooner had the initial plans been made than the nation was thrust into World War II.

The new institution forsook its own program and plunged into an accelerated war training program. Through its doors went 60,000 trained specialists who pooled their skills to aid industry and the armed services in

* **Director of public relations, Illinois Institute of Technology; editor,** *Illinois Tech Engineer.*

bringing a successful end to the great conflict.

Development program moves into high gear

With war's end, the long-delayed but carefully-planned building program moved into high gear. Work was started on two more classroom and laboratory buildings included in the master plan of Ludwig Mies van der Rohe, internationally famous architect who heads Illinois Tech's department of architecture.

Illinois Tech's notable strides in attaining its dual objectives of education and research last year were furthered by tangible progress in the physical development of the campus despite the many difficulties which currently beset all types of construction.

Completion of two new permanent buildings, the addition of five temporary war-surplus structures, and other miscellaneous construction during the past year will add close to 250,000 sq. ft. of floor space for educational purposes — approximately doubling that in use a year ago.

This will bring to nearly a half million square feet the total floor space in use for undergraduate and graduate education and research on the campus — all exclusive of the buildings in full and continuous use by the Research Foundation.

The new Chemistry Building, with modern facilities for teaching and research in the expanded chemistry department, is now in use. It is a three-story structure with 65,000 sq. ft. of floor space, located at 33rd and State streets, built at a cost of $740,000.

The building to house the metallurgical and chemical engineering departments has been delayed in construction and probably will not be fully in use until sometime after the start of the second semester. It is a two-story structure with 108,000 sq. ft. of floor space, located at 32nd and State streets, built at a cost of approximately $960,000.

These two additions and Alumni Memorial Hall, opened in 1945, will complete one section of the new campus. They provide splendid permanent quarters for an important part of the Institute's program. Space vacated in Main Building and Machinery Hall will permit expansion of the departments of electrical engineering, technical drawing, and mechanical engineering.

Equipment valued at a half-million dollars will be installed in the two new structures. About two-fifths of this is new; the remainder is war-surplus equipment assembled from war-time installations and furnished by the federal government at a small cost to the college.

Metallurgical engineering equipment — ovens, welding apparatus, heat treating equipment, machine tools, blowers, polishing wheels, quenching and testing equipment, etc. —is valued at $300,000. Chemistry laboratories and tables are valued at $175,000. The remaining $25,000 is the evaluation of auditorium seating, classroom chairs, and miscellaneous equipment.

An additional 67,000 sq. ft. of floor space is included in five temporary buildings supplied and installed by the Federal Works Agency, operating under a congressional act to provide educational facilities for veterans. The buildings were furnished without charge, but Illinois Tech paid for landscaping and installing utilities, walks, etc.

Illinois Tech was the first educational institution to request buildings under the federal act, and one of its five was the first moved and completed. The five, all one-story high, are:

Temporary No. 1, a classroom and laboratory building on the west side of Federal street between 32nd and 33rd streets, contains 18,400 sq. ft. It houses the greatly expanded business and economics department, mechanics department laboratories, drafting

James D. Cunningham, chairman of the board of trustees (left), and President Henry T. Heald break ground for one of the two dormitories now under construction. The ceremony took place October 7 at 32nd street and Michigan avenue.

Temporary Building No. 1, on Federal street between 32nd and 33rd streets, was one of the five war surplus buildings given to the Institute by the Federal Works Agency. This building houses offices and classrooms.

rooms, classrooms, and instructional staff offices.

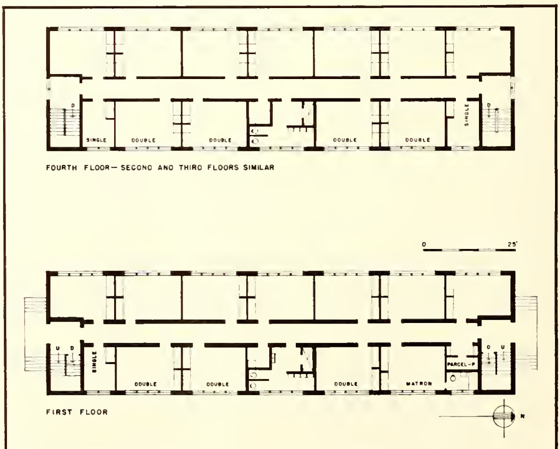
Temporary No. 2, a classroom and laboratory building on the west side of Federal street between 34th and 35th streets, contains 9,600 sq. ft. It provides quarters for the departments of industrial engineering and psychology and education, laboratories of these two departments, classrooms, drafting rooms, and instructional staff offices.

Temporary No. 3, a library annex on the east side of Federal street between 34th and 35th streets, contains 6,000 sq. ft. It has enabled the library staff to bring together for the first time all of Illinois Tech's libraries. In addition to 4,000 lineal feet of shelving for stacks, it contains a large reading room for students.

Temporary No. 4, the South Student Union, located on the north side of 34th street between Federal and Dearborn streets, contains 12,800 sq. ft. It contains a cafeteria capable of seating 300, student supply and book store, study hall and lounge, and offices for the student staffs of the college newspaper, yearbook, and student affairs association. The cafeteria kitchen was completely furnished with war surplus equipment.

Temporary No. 5, a gymnasium located at 32nd and Dearborn streets, contains 17,500 sq. ft. This structure, largest of the five, provides Illinois Tech with a complete gymnasium for the first time. It houses the department of physical education, including offices, supplies and equipment storage space, facilities for both men's and women's athletics, space for in-

(Please turn to page 32)



The floor plan for the two new dormitories.

Technology's Heritage

by **MENTOR L. WILLIAMS***

EVERYONE KNOWS THAT technology is, rightly or wrongly, the measure of contemporary progress; few realize that progress, even in this limited sense, is as ancient as man himself. Fewer still give thought to analyzing and understanding the impact of technology upon our civilization — its organization, its institutions, and its mores. It is a shameful fact that if one talks to an engineer or an engineering student born after 1900, one will discover that the world's Dark Age came to an end with the advent of Marconi, Edison, and the Wright Brothers. Nothing of significance to the technological world had its existence before the World's Columbian Exposition in Chicago in 1893. A feeling for the past, for historicity, is notably absent among those who develop and direct the technical achievements of today.

There are several reasons that can be advanced to explain this regrettable situation. History, as generally taught, lays emphasis on political and military fact. Only more recently has it begun to examine broader institutional patterns; social history has tried to make us aware of how people behaved at a given time; economic history has helped to clarify some of the more barren areas of the past. As yet, however, the average student still thinks of history as a matter of reigns and campaigns, with a few side trips into theology, art, and literature. Technology, if mentioned at all, is largely a recital of inventions. Not until after 1920 did historians "discover" the principle of interchangeability of parts—the basis of modern mechanization and mass production. Furthermore, the swift advance of technology and the rapid outmoding of materials, techniques, and processes give rise to the belief that the past is irretrievably dead and of little value in an atomic age. Let the dead past bury its dead; we make the future. Truly an heroic sentiment, albeit a banal and stupid one. History is not "bunk," a great technologist to the contrary. His achievements might have been more impressive had he understood the history of technology better and not tried to build his great industry on technical skill and intuition.

Recent studies in engineering education have made some practical suggestions about the social content of the engineering curricula. Recognizing that with all our engineering skill and know-how we still have misery, poverty, disease, slums, filth, smog, and bad transportation systems, the curriculum makers have recommended more attention to economics, political science, sociology, and history. This is as it should be and the more success to them. But a planned presentation of the social significance of technology in the history of man's development is still lacking in the revised program of studies. Some of the larger universities have sensibly introduced history of science courses; occasionally an agricultural or medical division offers an elective in the history of agriculture or of medicine (seldom advancing beyond description, however); but engineering schools have yet to develop an interpretative course in the history of technology.

At this point, the impatient listener wants to know why such a course should be developed and what good it would do: "Engineers are service people and deal with practical problems in a sensible way." Just so. But they are also citizens in a society where all the people are concerned with the world of tomorrow, a world that involves more than devices of construction and destruction. It is a world that involves leisure and the use of leisure, government and governmental controls, labor and the relation of labor to productivity, the family and economic consumption. The list can be extended endlessly. Upon all these areas the engineer knowingly or unknowingly exerts an influence. As a citizen it is his duty to know what that influence is likely to be. Through the history of technology he can discover what that influence has been. By the study of history he can see what he has done and what he is doing to society. It ought not be left to the sociologist alone to write and study the *Middletowns* of tomorrow.

Perspective, perspective, perspective. If anyone should know the meaning of that term, it is the technologist. He cannot approach the solution of any of his "practical problems" without perspective. In a broader sense, he cannot have a perspective of the present (the present in which his "practical problems" have their existence) unless he has an understanding of the technological past. It is not necessary that the technologist study the slowly developing processes and adaptations that have marked the growth of a particular machine or structure before he adds his adaptations to it, any more than it is necessary for the physician to learn Galen's "humors" or the chemist to learn alchemy. That would be foolish and time consuming. It is desirable, however, that he know something of the stages of technological growth through the ages, something of the phases or periods through which technics has passed. He should have more than the elementary school view of the stages of civilization: stone age,

* Assistant professor of English, Illinois Institute of Technology.

bronze age, iron age, age of steel — these afford only the slightest insight into the relation between man and his tools. And that other classification— a hunting stage, a pastoral stage, an agricultural stage, a commercial stage, and an industrial stage — has the virtue of hiding more about man's culture than it reveals, for it implies that real development in technology began only when steam power and automatic machinery were utilized in the textile industry. It is a naive view that the inventiveness of English artificers suddenly ushered in the Machine Age in the eighteenth century; it is even more naive to refer to the period since 1850 as the Age of Mechanization. The machine, simple or complex, has been in existence for thousands of years and the mere application of speed and efficiency to its operation means nothing in itself. Speed and efficiency are manifestations of psychological and social changes more than of physical changes. Behind the machine lie psychic and social unrest.

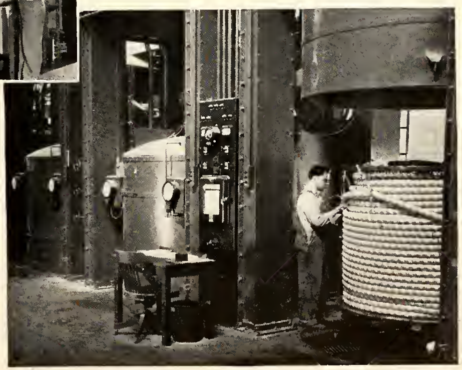
Most of the important tools, devices, and instruments upon which modern mechanization depends were known to the cultures of the past: clock, compass, water wheel; presses, pumps, screws, levers, hoists; loom, lathe, gunpowder, paper, mathematics. Engineering techniques, described by Vitruvius (one of Caesar's military engineers) in *Ten Books of Architecture*, were studied by French and Italian engineers of the fifteenth century. These engineers, in turn, took them to England; the French engineer, Lebelye, built the second London Bridge in 1738-1750. Newton translated Vitruvius in 1771. English experiments in the steam engine in the seventeenth and eighteenth century were directly inspired by sixteenth century translations of the *Mechanics* of Heron of Alexandria (first century A.D.). The internal combustion engine has its origin in the gun; the earliest experiments in internal combustion were undertaken with gunpowder; the latest experiments in internal combustion have utilized coal dust. As Alfred Leger (*Public Works in Roman Times*) has well said: "the new theories have most often but confirmed the old practice; we have improved the details without changing the principles." New materials, refined operations, mathematical analysis; it is these that modern technology has developed. And the reason for the phenomenal growth in these accurate, efficient refinements lies in the history of man, not in the history of machines. For machines follow needs.

"Necessity mothers invention" is a truism, but its full meaning is seldom understood. Perspective will help the engineer evaluate needs, and determine the difference between chaos and equilibrium, permanence and change. The history of technology provides him with a text.

To understand the role of technology in that social complex of ideas called "progress," the engineer must have a knowledge of the past developments in technics. Progress is more than the multiplication of means by which man masters the material world. It is not to be measured solely by the numbers of telephones or automobiles possessed, by the passenger miles flown in 1947, or by the kilowatt hours produced by the world's hydroelectric systems. Progress is not dependent upon the machine alone, nor upon the tool before the machine. In many respects the world of today is more barbaric, more primitive, more ugly than it was a thousand years ago. Some assert that the reason for this unpleasant fact is the machine and the failure of the engineer to make the machine function in terms of a whole and unified culture. The engineer ought not and cannot be blamed for what has happened; he can, however, act more intelligently if he understands what has happened. When science and technology shod the horse in the ninth century and made horse power, in a literal sense, a source of energy; when they covered the European lowlands with windmills and placed water mills on the banks of the rivers in the twelfth century; when they constructed pleasant villages and well-kept fields and gardens; when they produced durable goods and works of art in the period of the Hansa towns,—the aim was not mere control of environment but the enrichment and intensification of life itself. (See Lewis Mumford, *Technics and Civilization*, Chap. III.) In order that there may be real progress man must have fuller and greater opportunity to act rationally, to utilize the capacities that lie dormant within him. A later technology has lost sight of this basic fact in its desire to multiply energy and the products of that energy through more efficient machinery. Because we can throw things, including human beings, on the scrap heap more quickly, because we can wear things out more readily, this does not mean that we have reached the millennium.

If he is to have a conscious part in directing those forces that will create tomorrow's society, the engineer must know technology's past. The cultures of Greece and Egypt flourished because they captured and inherited the skills developed by earlier civilizations. Rome's greatness, in turn, was based on an uncanny ability to adapt and utilize the rich technical prizes that the conquest of Greece and Alexandria brought her. All roads led to Rome; all roads led, with equal truth, away from Rome. What happened when the Roman engineers applied their skill to road and bridge construction throughout Europe? What happened when Roman technologists developed blowers, pumps, and hoisting systems in the mines of Rome's heyday? What happened when Roman town planners laid out the right-angled streets, installed water and sewerage systems, baths and fountains in the colonial towns of the Em-

(Please turn to page 48)



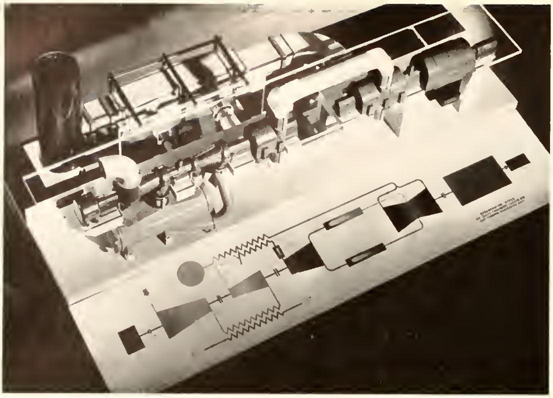


Fig. 6. A model of a 10,000 kw gas turbine unit.

Gas Turbines and Jet Propulsion

(Continued from page 8)

hour per square foot per deg F. The surface of the intercooler is 1.5 square foot per coupling hp, and an overall water-to-air coefficient of heat transfer of 20 Btu per hour per square foot per deg F is taken. The performance calculations for all of the cycles account for the pressure drops occurring in the various elements.

In all cases the thermal efficiency is defined as the ratio of the useful output at the coupling to the energy required from the fuel, each expressed in appropriate units.

Applications

While the gas turbine has had many years of historical background, it has come into practical significance only during the last decade. The previously mentioned Houdry installations represented the first relatively large-scale use of the gas turbine. At the present time the gas turbine is being used in greatest numbers in aircraft applications, embodying principally the jet propulsion of military aircraft. Due to its many advantages however, the gas turbine is ideally suited to numerous uses in land, marine, rail, and aircraft fields, and these will be discussed individually.

The first gas turbine of prime-mover type in the United States was placed in service in 1936 as a part of the aforementioned Houdry process. At present there are about 28 gas turbines of this type in the United States. Of these, Brown-Boveri has built six, and the remaining 22 have been built by Allis-Chalmers, originally a licensee of Brown-Boveri. Allis-Chalmers has also built 10 for foreign operation. An installation view of a 60,000 cfm, Allis-Chalmers, Houdry unit, the largest in the world, is shown in Fig. 5. From left to right may be seen the gas turbine, axial compressor, reduction gear, generator, and a steam turbine for starting purposes.

In 1940, a 4000 kw Brown-Boveri electric generating unit was installed in an underground stand-by power plant in Neuchatel, Switzerland. Tests on this unit, operating on the basic cycle, indicated a coupling thermal efficiency of approximately 18 percent with a turbine inlet temperature of 1000 F. No regeneration was justified in this instance due to the restricted and intermittent nature of the operation.

A model of a 10,000 kw gas turbine unit proposed by Allis-Chalmers for utility service is shown in Fig. 6. The diagram of its regenerative cycle with reheating and intercooling may also be observed. The 10,000 kw generator is driven by a separate, double-flow, low pressure turbine, while the high pressure turbine, on another shaft, drives the compressors. A coupling thermal efficiency of 30 percent is expected with an inlet temperature

(Please turn to page 24)

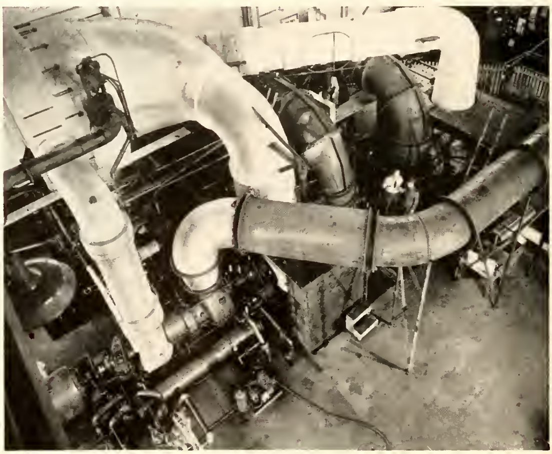


Fig. 7. A 3,500 hp, 1,500 F, gas turbine on the test floor of the United States Naval Engineering Experiment Station at Annapolis, Md.

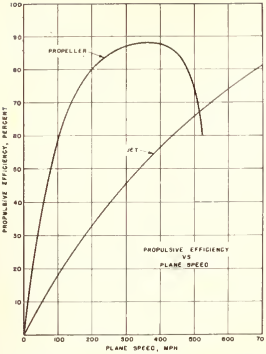


Fig. 8. The effect of plane speed upon the propulsive efficiency of jet and of a typical propeller.

(Continued from page 22)

of 1300 F to both turbines, and effectivenesses of intercooler and regenerator equivalent to 85 and 75 percent, respectively.

For naval and maritime duty the small space and weight requirements of the gas turbine render it particularly suitable. Electric drive or the use of a variable pitch propeller would mitigate the reversing problem, which is more acute with gas turbines because the minimum pressure in the cycle is atmospheric. If a conventional type of astern turbine, as used in steam practice, were rotated in such an atmosphere, the windage losses would be prohibitive.

A 3500 hp, 1500 F, gas turbine, built by Allis-Chalmers for the bureau of ships of the U. S. Navy, is shown in Fig. 7 on the test floor of the U. S. Naval Engineering Experiment Station at Annapolis, Maryland. This unit is the largest gas turbine in the world for this temperature. It operates on a cycle comprising an axial-flow compressor driven by a turbine, while the second turbine operating in parallel on another shaft furnishes the useful output. Air discharged from the compressor traverses a regenerator where it is heated indirectly by the combined exhaust gas from both turbines. The preheated air next divides itself between two combustion chambers where fuel is added, furnishing the high temperature motive fluid to the turbines.

In the lower left corner of Fig. 7 one may see the axial compressor connected to its driving turbine. The power turbine is on the upper right in line with the other rotating elements. Connected to the power turbine is a water brake dynamometer (not visible). The regenerator in the upper left has three large pipes (white insulation) entering it, which, from left to right, are the compressor discharge, compressor turbine exhaust, and power turbine exhaust. Directly under the regenerator are located the two combustion chambers from which one may see emerging the turbine inlet connections. The compressor intake air is supplied through the lower pipe in the figure.

While the gas turbine has certain distinct advantages for each of its respective fields of application, it would appear that its greatest usefulness would be in the heavy traction field, in all probability the most desirable application. Of particular interest for railway locomotive use are various features of the gas turbine such as its freedom from water requirements, its purely rotary motion, its low lubrication costs, its unique ability to utilize dynamic braking by absorbing energy in the main compressor, its good thermal efficiency,

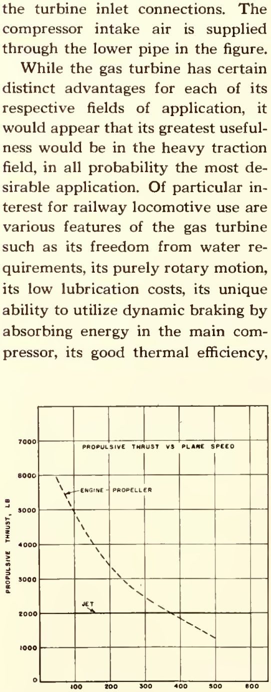


Fig. 9. The effect of plane speed upon the propulsive thrust of a gas turbine jet engine and a reciprocating engine-propeller combination.

and the possibility of its using solid fuels.

Up to the present time one gas turbine locomotive has been built. This 2200 hp, oil-fired, Brown-Boveri unit was completed in 1941 for the Swiss Federal Railways. The gas turbine operates on a regenerative cycle with a maximum thermal efficiency of 18 percent at the coupling. The 70 mph locomotive has a DC electrical transmission, and a specific service weight, including fuel, of 92 lb per bhp.

In order to develop a coal-burning locomotive which would compare favorably with the diesel locomotive, a Locomotive Development Committee, consisting of nine railroads and four coal companies, was established in 1944 in the United States as an agency of Bituminous Coal Research, Inc. The gas turbine has been selected as the prime mover which best adapts itself to the requirements involved. The research work of the committee is under the direction of J. I. Yellott. The committee has purchased two gas turbine locomotives which are scheduled to be on the rails in 1948. Allis-Chalmers is furnishing a 3750 hp gas turbine electric power plant with controls for one of the locomotives. The plant will consist of a six-stage reaction turbine driving a 20-stage axial compressor.

The coal handling and combustion phases of the project are undergoing intensified development at the present time in various laboratories throughout the United States. The proposed arrangement of the equipment on the locomotive is such that the coal will pass from a bunker to a crusher and then to pressurized tanks. Pulverization of the crushed coal is accomplished by expanding it with air through a nozzle so that the sudden release of pressure causes the coal to disintegrate into fine particles. The powdered coal is then burned in a combustion chamber and the resulting hot gas, before entering the turbine, passes through an ash separator which removes most of the solid particles that might otherwise damage the turbine blading.

Gas turbine development under-

(Please turn to page 26)

DU PONT *Digest*

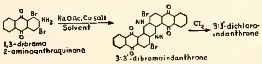
For Students of Science and Engineering

Development of dyes requires both physical and organic chemistry

The synthesis of a new dye in the laboratory or even the development of a manufacturing process from that synthesis may still be a long way from the realization of the full potentialities of the new compound as a coloring material. This is illustrated by the commercial history of the exceedingly fast bright blue dye indanthrone and its halogen derivatives.

Indanthrone was the first known anthraquinone vat dye and has led tonnage sales of vat dyes in the U.S. since its introduction, despite the commercial use of well over 200 types. In 1901, Bohn first synthesized indanthrone by KOH fusion of 2-aminoanthraquinone, but the yields obtained were in the range of only 25-30 per cent. Because of the industrial importance of indanthrone, and the low commercial yields obtained by the original fusion procedure, a great deal of research time has been spent in its study.

Several U.S. patents record the fact that Du Pont organic chemists have made outstanding contributions in this field, particularly by developing the intercondensation of 2 moles of 1,3-dibromo-2-aminoanthraquinone and replacing the bromine by chlorination to give 3:3′-dichloroindanthrone ("Ponsol" Blue).



This fixes the chlorine in the desired positions to give a product with greater bleach-fastness than indanthrone and minimizes extraneous substitution that always accompanies direct chlorination of indanthrone. The commercial yields of 3:3′-dichloroindanthrone now being obtained by Du Pont are markedly greater than those obtained by Bohn and his workers.

It is just as important, however, that a water-soluble dye be made in a physical form that gives optimum shade and working qualities, such as perfect dispersion, freedom from specks, rapid reducibility and storage stability. A significant Du Pont contribution to the production of vat dyes in optimum physical form is called "turbulent flow drowning." In this procedure, the color is dissolved in strong H_2SO_4 and then diluted by a large volume of water in a constricted tube. High turbulence is maintained during dilution and produces uniform dye particles.

In this development the work of physical chemists and physicists, aided by electron microscopy, ultra-centrifuging, infrared and ultra-violet spectrometry and other modern techniques, was of major importance.

One of the three wings of the Jackson Laboratory, where a large portion of the basic research on dyes is carried on. The new $1,000,000 addition on the right is nearing completion.

The conversion of laboratory findings to a plant operation often presents unique and difficult problems that require unusual ingenuity on the part of chemists, chemical, mechanical and electrical engineers. The work on the indanthrones was no exception. The outstanding commercial success of "Ponsol" vat colors, typified by "Ponsol" Blue is one example of the results achieved through cooperation of Du Pont scientists.

★ ★ ★

Questions College Men ask about working with Du Pont

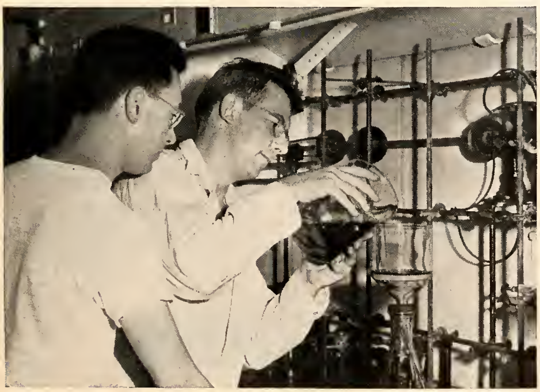
WILL I GET LOST IN A BIG COMPANY?

The organization of Du Pont is unique in that each of its ten manufacturing departments and two technical staff departments is responsible for its own operation. Furthermore, new chemists and engineers work in small groups under experienced supervisors. Du Pont's group system assures men of interesting and friendly working conditions plus the broad avenues of promotion that go with size. Write for the new booklet, "The Du Pont Company and the College Graduate," 2521 Nemours Building, Wilmington 98, Delaware.

DU PONT

REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING ... *THROUGH CHEMISTRY*



W. R. Remington, Ph.D., University of Chicago, 1944, and S. N. Boyd, Ph.D., University of Illinois, 1945, working on a dye research problem.

(Continued from page 24)

went major advances during World War II, principally because of the military potentialities involved. Many millions of horsepower of aircraft gas turbine superchargers were manufactured for use in such planes as the B-17, B-24, and P-38. During the later stages of the war research on aircraft gas turbine jet propulsion engines was being accelerated at a rapid rate, and production was in process when hostilities ceased.

Owing to the termination of the war, and also to the fact that the trend for military aircraft is away from reciprocating engines and toward gas turbine power plants, production of turbo-superchargers has been tremendously curtailed. On the other hand, development and production of aircraft gas turbine power plants have progressed steadily and are being rapidly augmented by the entry of additional companies into the field.

One may ask why the gas turbine has had such recent widespread adoption in the aeronautical field, particularly for the jet propulsion of military planes. Some of the natural advantages of this type of prime mover, as already stated, are partially responsible; but, in addition, the aerodynamic limitations of propellers in the highest speed ranges have dictated the transition to the other method of propulsion. Reference to Fig. 8 will furnish a comparison between the propulsion efficiencies of a typical propeller and jet, as a function of plane speed. In the high speed range, beyond 500 mph, the efficiency of the propeller is diminishing rapidly, while that of the jet is improving almost linearly. It is understood that recent propeller designs have indicated the possibility of maintaining acceptable efficiencies at higher speeds, but it is expected that they will still exhibit a drooping characteristic which would render them inferior to the jet in the highest speed regions.

A comparison of propulsive thrust at a given altitude as a function of plane speed for a reciprocating engine-propeller combination and a gas turbine jet engine may be obtained from Fig. 9. The figure has been somewhat simplified for illustrative purposes in that the jet engine is indicated as a constant thrust device, which is essentially correct except that a slight decrease in thrust will occur with increase in plane speed. The excellent thrust characteristics of the engine-propeller arrangement are readily apparent at the lower speeds; however, the continuing declination in propeller thrust causes it to become less than that of the jet engine, so that the latter is more suitable for high speed flight. In Fig. 9 the reciprocating engine and the jet engine have been arbitrarily selected so that each produces 2000 thrust horsepower at 375 mph.

In a supercharged engine-propeller arrangement the brake horsepower will be essentially constant with plane speed. The useful or thrust horsepower will be equivalent to the prod-

(Please turn to page 28)

(Continued from page 26)

uct of the brake horsepower and the propeller efficiency. The shape of the thrust horsepower curve will be similar to that of the propeller efficiency curve, and will tend to fall off at high speeds. Since the thrust of the gas turbine jet engine is depicted as constant, its thrust horsepower will vary linearly with plane speed. Superimposing a curve depicting the power required for a typical plane, it is indicated that the maximum speed of the jet plane would be 600 mph, compared with approximately 485 for the plane with a propeller. On the other hand, the respective minimum flying speeds would be approximately 125 and 90 mph, so that the jet plane would require a longer runway for landing and take-off operations.

From a fuel economy standpoint, the engine-propeller arrangement is vastly superior at the lower plane speeds, but loses its advantage beyond approximately 530 mph. The propeller engine has a maximum overall thermal efficiency of about 22 percent at 350 mph, which is more than double that of the jet engine for the same speed. The jet engine thermal efficiency gradually increases with plane speed, however, until at 530 mph it equals that of the conventional engine, and reaches about 14 percent at 600 mph. The specific fuel consumptions of the two types of power plants will vary inversely as their respective thermal efficiencies, as shown in the figure. Fuel costs will not be proportional to these latter curves since the reciprocating engine uses high octane gasoline, whereas the jet engine burns kerosene, a much cheaper fuel.

The gas turbine jet propulsion engine consists of the same basic elements as those of the gas turbine power unit shown in Fig. 1. Instead of furnishing excess power which would drive a device such as the generator of Fig. 1, however, the turbine of the jet engine only develops sufficient power to drive the compressor, and the excess energy is in the high velocity exit jet which propels the plane. Variations of pressure, temperature, and axial velocity throughout the engine should also be noted. The axial velocity of the motive fluid is greater at exit than at inlet; thus the gas turbine engine contributes to the creation of a change in momentum in the fluid, by virtue of which the propulsive thrust is produced.

One of the gas turbine jet propulsion units built by Allis-Chalmers during the recent war, under license agreement with the de Havilland Engine Co. Ltd., of England, employs a one stage centrifugal compressor, with single-sided entry of air, driven by a single-stage turbine. The unit develops a static sea level thrust of 3000 pounds when rotating at 10,500 rpm with a turbine inlet temperature of 1500 F. The complete weight with all auxiliaries is 1500 pounds, resulting in a specific weight of 0.5 pounds per pound static thrust. The fuel consumption is approximately 1.2 pounds per hour per pound static thrust. The maximum overall diameter is 50 inches. The air discharged from the compressor is led to 16 individual combustion chambers and, after addition of fuel in each, enters as a hot gas the common nozzle ring supplying the turbine wheel. The residual kinetic energy of the gas leaving the turbine enhanced by a subsequent expansion provides the propulsive jet for propelling the aircraft.

The jet-propelled Lockheed Shooting Star, the P-80, a military fighter plane, was powered by a similar de Havilland engine in its early stages. In June, 1947, the latest version of this plane, the P-80R, with an Allison Model 400 jet engine, established a world's speed record of 623.8 mph at sea level. The engine, weighing 1735 pounds, is rated at 4600 pounds static thrust, and is believed to have delivered close to 7000 pounds thrust during bursts with alcohol-water injection. In August, 1947, a new world's speed record of 650.6 mph was set by the Douglas D-588 Skystreak, a jet-propelled transonic research plane.

The characteristics of jet engines are not readily comparable with those

(Please turn to page 30)

Exploration of ocean depths is made possible by RCA Image Orthicon television camera.

The ocean is a "goldfish bowl" to RCA Television!

Another "first" for RCA Laboratories, undersea television cameras equipped with the sensitive RCA Image Orthicon tube were used to study effects of the atom blast at Bikini . . .

There may come a day when fishermen will be able to drop a television eye over the side to locate schools of fish and oyster beds . . . Explorers will scan marine life and the geology of the ocean floor . . . Undersea wrecks will be observed from the decks of ships without endangering divers.

With the new television camera, long-hidden mysteries of the ocean depths may soon be as easy to observe as a goldfish bowl—in armchair comfort and perfect safety.

Exciting as something out of Jules Verne, this new application of television is typical of research at RCA Laboratories. Advanced scientific thinking is part of any product bearing the name RCA, or RCA Victor.

When in Radio City, New York, be sure to see the radio and electronic wonders at RCA Exhibition Hall, 36 West 49th Street. Free admission. *Radio Corporation of America, RCA Building, Radio City, New York 20.*

Continue your education with pay—at RCA

Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short wave and FM circuits, television, and phonograph combinations).
- Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.
- Design of component parts such as coils, loudspeakers, capacitors.
- Development and design of new recording and reproducing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

Write today to National Recruiting Division, RCA Victor, Camden, New Jersey.

Also many opportunities for Mechanical and Chemical Engineers and Physicists.

RCA RADIO CORPORATION of AMERICA

(Continued from page 28)

of conventional engines with propellers, since the former are rated on a thrust basis, and the latter on horsepower. It should be noted, however, that the specific weight of a jet engine will be considerably less than that of a reciprocating engine including propeller. Since the thrust horsepower of a jet engine continually increases with plane speed, the basis of comparison with a conventional engine is not obvious. As a means of establishing an example, however, let it be assumed that a comparison will be made at 400 mph. At this speed, at a given altitude, the thrust horsepower of a jet engine is approximately numerically equivalent to its static thrust. Thus the specific weight of a jet engine at 400 mph would be about 0.4 to 0.5 pounds per thrust horsepower.

Assuming that a reciprocating engine weighs 1.1 pounds per brake horsepower, when the propeller, a necessary feature to complete the power plant, is included, the total specific weight will approach 1.6 pounds per brake horsepower, for modern high speed propellers. With a propeller efficiency of 85 percent, the specific weight becomes about 1.9 pounds per thrust horsepower, which is approximately four times the corresponding figure for the jet engine. It should also be recognized that this ratio enlarges with speed, since the thrust horsepower of a conventional engine decreases, and that of a jet engine increases, with plane speed.

The present discussion on jet propulsion has been confined to jet engines of the pure jet type—that is, where all of the propulsive energy is in the form of a high velocity jet. This type is best suited for the maximum speed range. For intermediate speeds, however, modifications referred to as prop-jet engines are more applicable. This latter type consists of a gas turbine engine where approximately 80 percent of the output is delivered to a propeller, and the remainder is represented by the exhaust jet. Engines of this type have better fuel economy than pure jet designs under 500 mph.

Conclusions

This paper has attempted to present, in rather brief form, some design features, performance characteristics, and applications of gas turbines. The aircraft application, particularly with reference to its jet propulsion phase, has been dwelt upon at some length. There appeared to be sufficient justification for discussing it in comparative detail, since it is the application of the gas turbine which has the greatest magnitude and popular appeal at the present time.

It is desired to emphasize that, notwithstanding its many advantages and attractive potentialities, the gas turbine is not regarded as a panacea for all power problems, for its limitations are also well recognized. It is believed, however, that there are many applications for which the gas turbine is ideally suited, and it is toward such ends that its present development is being directed.

Her compact passed 65 screen tests

Be it made of gold, silver or "brass", a compact has to pass a lot of "screen tests" on its way from the earth to its user.

Ore is screened a score of times before it becomes metal. Silica goes through a battery of screens to become a mirror. And talcum is forced through a long series of fine-mesh screens before it acquires that caressing smoothness that is demanded by our exacting fair sex.

Yet, because this is America, compacts which are beyond the means of women living in countries that decry our free enterprise system, are sold in dime stores, available to millions.

Roebling products play a leading part in this mass production. Roebling wire screens meet all materials under all conditions. In one case they pass rocks as big as melons. In another they reject dust as fine as pollen.

Made of steel rods as thick as your thumb, or woven of stainless as fine as hair, Roebling screens serve industry in a hundred ways—on a thousand jobs.

JOHN A. ROEBLING'S SONS COMPANY
TRENTON 2, NEW JERSEY
Branches and Warehouses in Principal Cities

A CENTURY OF CONFIDENCE **ROEBLING**

A model of the two four-story dormitory units now under construction on the Illinois Tech campus at 32nd street and Michigan avenue and 33rd street and Michigan avenue.

Illinois Tech Builds

(Continued from page 18)

door baseball, an area large enough to accommodate two simultaneous basketball games, and 600 lockers.

Increased physical facilities on the Illinois Tech campus permit centralization of instruction not possible before. This fall, for the first time, the architecture department is housed completely on the campus—in Alumni Memorial Hall, first classroom building completed in the master program.

Illinois Tech's NROTC unit, termed by the Navy "the best equipped in the nation," will continue to occupy quarters in the building.

Eventually all activities of the Institute will center on the south side campus. With the moves this fall, the only units remaining downtown are the department of home economics, the Institute for Psychological Services, and certain classes conducted by the Evening Division.

Major rehabilitation of existing buildings has added to their usefulness and attractiveness. The student lounge in the North Student Union has been entirely refurnished, the main cafeteria rearranged, a new conference and dining room provided in the space formerly occupied by the book store. A small permanent building to handle the central power distribution system was constructed during the year.

Illinois Tech's over-all development extends over a 100-acre tract from 31st to 35th street and from Michigan avenue to the New York Central railroad tracks. The east section of this area, extending the full length north and south between State street and Michigan avenue, will be devoted to housing.

Of necessity, the Institute's interest must extend far beyond the limits of its own campus in providing housing for its students and staff. In the early stages of planning the campus development, it became apparent that the future of the Institute and its program was inevitably tied in with the development of the whole south side of Chicago.

In the congested city of Chicago, a scheme of sensible city planning was needed—not only to provide housing, but to clear the teeming slum areas. The South Side Planning Board, with President Heald as chairman, took the lead in planning the

(Please turn to page 34)

Students walk from classes in Alumni Memorial Hall, the first building completed in the Institute's huge post-war construction program.

(Continued from page 32)

redevolpment of the seven-square-mile blighted area on Chicago's south side.

Illinois Tech later joined forces with the South Side Planning Board and four other private and public organizations to frame an over-all plan of urban redevelopment. The four are:

Michael Reese Hospital, whose board decided in 1945 to "stand and fight," just as Illinois Tech had previously determined to do; the Metropolitan Housing Council; the Chicago Housing Authority, and the architectural firm of Pace Associates.

Illinois Tech's share in the development of the seven-square-mile blighted area which surrounds it is two-fold: 1) its educational and research campus, and 2) its adjoining housing program. This will include 12 dormitories, each housing 109 students; three 10-story elevator apartments, each with 120 apartments of one- and no-bedroom type; three 3-story walk-up apartments, each with 36 apartments of the two-bedroom, one-living room type; row houses for faculty, and a community building and central dining hall with nearby garages.

An historic ceremony October 7 at 32nd street and Michigan avenue marked the first step in the housing redevelopment of Chicago's near south side. Ground was broken for the first of two dormitories now under construction for Illinois Tech. President Heald and James D. Cunningham, chairman of the board of trustees, turned the first soil in excavating for the foundation.

Scheduled for completion next summer and use next fall, the dormitories (the second is one block south at 33rd and Michigan) are being built by W. E. Schweitzer and Company, Chicago contractors. Architects for the housing units are Skidmore, Owings, and Merrill, who have designed them to coincide with the classroom buildings of Mies van der Rohe.

Each of the four-story walk-up dormitories will house 109 out-of-town students. Cost of each is expected to approximate $275,000, including land and improvements. Quarters in each will consist of 51 double rooms, 7 single rooms, and a matron's suite. A separate wing, originally planned to contain a cafeteria and lounge for each, will not be built now.

The buildings will be fully fireproof. Flooring will be asphalt tile, ceilings will be painted concrete slab, and walls will be painted plaster. Heat will be furnished by hot water radiators from central oil heating plants and boilers in each building. A shower room will be included on each floor.

The dormitories are being built on opposite ends of Illinois Tech's present fraternity row along Michigan avenue. Five fraternity houses and the the only present dormitory, housing 92 students, are located in the 3200 block along the west side of Michigan avenue in a section once renowned as one of the finest residential areas in the city.

Illinois Tech looks to the future

At no time since the formation of Illinois Tech in 1940 has there been such tangible evidence of physical advancement. The casual visitor to the campus cannot help but be impressed by the rising structures, the buzzing activity, the feeling of growth and advancement which permeates the atmosphere as Illinois Tech builds.

But the building is not an end in itself. As President Heald has put it:

> **"We have two distinct services to offer —education and research. We want to provide the best possible professional and cultural education for our students. We want at the same time to contribute through research to mankind's knowledge of the world in which we live so that the lives of all of us may be enriched and made more enjoyable.**
>
> **"These, then, are our objectives. We are striving endlessly to achieve them and to discharge our obligations to our students, to ourselves, and to the society which supports us."**

Illinois Tech is building more than structures of steel and concrete and brick. It is building a foundation for the reclamation of human dignity in a slum area. And it is building a great technological institution to fulfill its destiny in the great Middle West.

If you can catch a leprechaun...

A leprechaun, according to Irish legend, is a dwarf who keeps a pot of gold hidden away.

If you can catch a leprechaun, your troubles are over.

Because he keeps his gold just for ransom money. If you catch him, he'll quickly tell you where his gold is, so you let him go.

The best place to look for a leprechaun is in the woods. They're green, and only about nine inches tall, so you'll have to—

Or maybe you don't believe in leprechauns.

Maybe it would be more practical to just keep working for your money. But you can learn one good lesson from these little fellows. A small pot of gold put to one side is a great help when trouble catches *you.*

And there's a much faster and easier way to get your pot of gold than by catching leprechauns. You can buy U. S. Savings Bonds through an *automatic* purchase plan.

If you're employed you can sign up for the Payroll Savings Plan. If you have a bank account you can sign up for the Bond-A-Month Plan. Either way, your pot of gold just saves itself, painlessly and automatically.

And your money increases one third every ten years. That would make a leprechaun turn even greener with envy.

Save the easy, automatic way—with U.S. Savings Bonds

Contributed by this magazine in co-operation with the Magazine Publishers of America as a public service.

Tenth Annual

Midwest Power Conference

THE TENTH ANNUAL meeting of the Midwest Power Conference will be held at the Sheraton Hotel (formerly Hotel Continental), 505 North Michigan Avenue, Chicago, on Wednesday, Thursday, and Friday, April 7, 8, 9, 1948.

The Midwest Power Conference was revived and reorganized in 1938. At that time it was placed under the sponsorship of Armour Institute of Technology and was operated with the cooperation of other midwestern universities and local and national engineering societies. Upon the consolidation, in 1941, of Armour Institute of Technology and Lewis Institute into Illinois Institute of Technology, the sponsorship was automatically assumed by the latter.

Conferences have been held each year with the exception of 1945, when the meeting was cancelled because of wartime restrictions on travel. Throughout the last ten years, the list of cooperating institutions has grown steadily, until at present it includes the Universities of Iowa, Illinois, Michigan, Minnesota, and Wisconsin, Iowa State College, Michigan State College, Northwestern University, Purdue University, the local sections of the American Institute of Chemical Engineers, American Institute of Electrical Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers, American Society of Civil Engineers, American Society of Heating and Ventilating Engineers, the Western Society of Engineers, the Engineers' Society of Milwaukee, and the National Association of Power Engineers. Success of the conference has been due to the cooperation of all of these institutions.

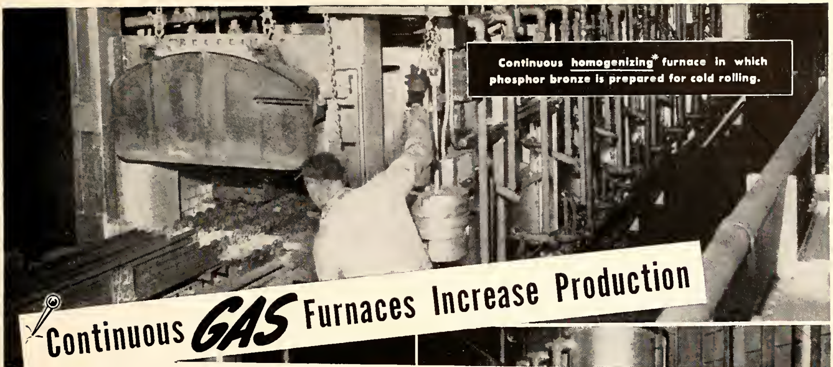
The preliminary program of the 1948 meeting is being formulated by Stanton E. Winston, conference director, and Edwin R. Whitehead, conference secretary, with the collaboration of representatives of the cooperating institutions and the following members of the staff of Illinois Tech and Armour Research Foundation: Professors Roland A. Budenholzer, William Goodman, William A. Lewis, John T. Rettaliata, Otto Zmeskal, Jesse E. Hobson, K. W. Miller, and E. H. Schulz.

In addition to the popular opening meeting and four electrical sessions, it is anticipated that the program will include sessions on central station practice, developments in heating and air conditioning, diesel power, hydro power, fuels and combustion, small steam power plants, electronics in industry, metallurgy of power plants, feedwater treatment, civic responsibilities of the engineer, atomic power, the gas turbine, and locomotive power. From six to eight sessions will be held on each of the three days of the conference. The program will again feature joint luncheons with the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Western Society of Engineers as well as the main event, the All-Engineers Dinner.

The preliminary program will be ready for distribution early in February, and will be printed in full in the March issue of this magazine.

Officials of the conference have extended an invitation to all who are interested in the field of power, and in the nation's power problems. Hotel reservations should be made as quickly as possible.

All inquiries concerning the conference may be addressed to Edwin R. Whitehead, conference secretary, c/o Illinois Institute of Technology, Chicago 16, Illinois.



Continuous GAS Furnaces Increase Production
Reduce Cost of Heat Treating Phosphor Bronze

Roller hearth radiant tube heated furnace using prepared atmosphere for bright annealing.

ELEPHANT BRAND Phosphor Bronze PHOSPHOR BRONZE REG. U.S. PAT. OFF.

Atmosphere generating equipment used with bright annealing furnace.

Customers of Phosphor Bronze Smelting Company, 2200 Washington Ave., Philadelphia, started the whole thing—they demanded more Elephant Brand Phosphor Bronze products than the company could produce by former methods of heat treating.

So company production engineers, already familiar with GAS and Gas Equipment, specified the modern method of heat treating—with continuous, automatically-controlled, Gas Furnaces, with integral prepared atmospheres.

Here are the processes . . .

Process—*Homogenizing—a method of heat treating to develop uniform grain structure in phosphor bronze billets prior to rolling, while relieving casting strains.

Temperature—1200° F.

Cycle—6 hours

Furnace Capacity—2000 lbs. per hour

Process—Annealing of bars and sheets in a prepared-atmosphere furnace to retain brightness while relieving stresses set up during rolling or drawing operations.

Temperature—1200° F.

Cycle—40 minutes to 3 hours, varying with stock size

Furnace Capacity—5000 lbs. per hour

Here are the results . . . .

1. Pickling process eliminated
2. Production increased 80%
3. Uniformity of heat treatment assured by automatic control
4. Annealing and homogenizing costs reduced over 50%
5. Working conditions improved

Throughout industry modern Gas Equipment has established cost-cutting and time-saving records wherever GAS heat treating methods and machinery have been integrated in production-line processes.

AMERICAN GAS ASSOCIATION

420 LEXINGTON AVENUE, NEW YORK 17, N.Y.

MORE AND MORE... THE TREND IS TO GAS FOR ALL INDUSTRIAL HEATING

John Neal

(Continued from page 13)

novel to develop the tragic implications of the Salem witchcraft trials of 1692 as more than a background for sentimental romance. In this description of the execution of a helpless, harmless old woman we have an excellent example of Neal's "natural," flowing style and of his theory of natural eloquence—the repetitious, broken, unimaginative exclamations of an old woman confronted with death. George Burroughs, the central character, has just departed after delivering a final vain plea for clemency:

"She could not believe it . . . she would not believe it—she did not—such was her perfect simplicity, till the chief judge came to her and assured her with tears in his eyes, over and over again, that it must be so.

Ah me! said poor Martha, looking out toward the quarter of the sky where the horseman had so hastily disappeared, and where she had seen the last of the firelight struck from his path; Ah me, bending her head to listen, and holding up her finger as if she could hear him on his way back. Ah me!—ah me— and that was all she said in reply to her judges, and all she said when they drove her up to the place of her death, decked out in all her tattered finery, as if it were not so much for the grave, as for a bridal that she was prepared.

Ah me, said poor Martha when they put the rope about her neck . . . Ah me!—and she died while she was playing with her little withered fingers, and blowing the loose grey hair from about her mouth, as it strayed away from her tawdy cap . . . saying over the words of a child in the voice of a child, Ah me—ah me—with her last breath—"

In *Authorship* (1830) the colloquial style is employed for a very different emotional effect. The narrator of the story (Neal in thin disguise) relates his experiences as a New Englander visiting Britain. He is a man of extreme sensibility, acidulous in his observations of British customs and institutions, and ludicrous in his excessive susceptibility to minor mishaps and discomfitures: he devotes an entire chapter to his ordeal in getting a breakfast egg in a British inn. And he is extremely susceptible to the charms of a mysterious young lady: he devotes almost an entire chapter to holding her hand, though he is not at all aware of that fact until her husband enters. It is all done with a deftly controlled casualness, largely managed through a series of "natural" conversations, and has much of the nuance and charm of Sterne's *A Sentimental Journey*.

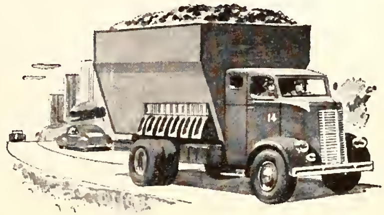
Neal's continuous preoccupation with the real speech of real people is best illustrated by his representation of Yankee speech and character in *The Down-Easters* (1833). Neal delights most in telling how the ludicrous but shrewd Yankee invariably gets the better of his dignified neighbors who have the educated habit of not saying what they mean.

In one instance, a pompous old gentleman offers his fork to his fellow-diner, a Yankee, requesting him with grave dignity *to put his fork into a potato.* The Yankee takes the proffered implement, thrusts it into a potato, *and leaves it there.* The pompous gentleman stares and then with a bow and a compassionate smile tells the Yankee *he'd be obliged to him for his fork.* Whereupon the Yankee, with a literal innocent air, bows in reply, pulls out the fork, and returns it across the table.

On another occasion, a Yankee peddler, upon encountering a gentleman suffering from severely chapped

(Please turn to page 40)

When you admire a beauty[1] . . . or visit a farm[2] . . .



ride on a ferry[3] . . . . or order some coke[4] . . .

swallow an aspirin[5] . . . . or turn on the light[6] . . .

the chances are, you are coming in contact with Koppers engineering or chemical skills.

1. Koppers chemicals for use in cosmetics. **2.** Farm structures made of lumber pressure-treated by Koppers for long life. **3.** Koppers American Hammered Piston Rings for marine engines. **4.** Coke from Koppers-built ovens. **5.** Koppers chemicals for use in medicines. **6.** Koppers Fast's self-aligning couplings, widely used in power plants. All these are Koppers products . . . as well as scores of others that help to increase our comfort, guard our health, enrich our lives. All bear the Koppers trade-mark, the symbol of a many-sided service . . . and of high quality. Koppers Company, Inc., Pittsburgh 19, Pa.

K

KOPPERS

(Continued from page 38)

lips, attempts to sell him some infallible ointment. When his prospective customer turns him off with great rudeness, the Yankee holds up his ointment jar and says:

> **"Frind!—I meant no offence, an' I'm sorry for it; but if you'll allow me to express my opinion, I should say that a LEETLE o' that are—a very LEETLE—scooping out as much as he could with his thumb-nail, and holding it up—not more 'an you'd want to soap a griss-mill with—jess slicked over your lips, INSIDE AN' OUT, you'd be a much easier man for the rest o' the day; an' talk more to other people's satisfaction."**

It was to be expected that Neal, with his great interest in natural expression, would show great interest in children and in the eloquence of children. He felt that they were a link to nature—"the cryptogamia of another world" — and that their speech reflected the true, natural function of language:

> **"You CHOKE my hand, said a little fellow once, when I was holding him by it.—His father laughed . . . his mother shamed him. I felt proud of him.—Faver—said another, in my presence—there's an old man, Sir—he's been SHAVING the wall. On inquiry, we found that he had been whitewashing the wall. The boy had seen his father's face covered with soap and lather when he shaved. . . . Will you persuade me that either of those children did not FEEL the analogy and propriety of language?"**

And so Neal collected the sayings of children, and attacked as adult betrayals the absurdity and artificiality of the children's stories of the period, and wrote several stories himself that reflected his own theory as to what a child's story should be like.

Neal campaigns for rights of women

After his return to Portland, Neal devoted more and more of his time and energy to non-literary activities. He had become attracted to Jeremy Bentham's philosophy during his visit to England and translated his *Principles of Legislation* shortly after his return. He plunged into local affairs and played a vociferous part in furthering civic improvements ("our streets were impassable at certain seasons of the year . . . and if you saw an aged man poking about in the mud, with a cane, you were tempted to ask if anybody was missing"). He lectured on gymnastics and founded several gymnasia; but he quit this activity after being enraged by the hypocrisy of his abolitionist class-leaders who rejected flatly the membership applications of several Negro youths ("for what was bodily training, compared with spiritual training? what a system of gymnastics, weighed against humanity and consistency?"). He lectured and wrote extensively on education and the dignity of labor (ivory-tower intellectuals were useless and the only true system of education was self-education). He wrote extensively on American art and artists demanding of them, as he did of writers, vigor and independence in place of the slavish imitativeness so much in vogue. He was an authority and prolific writer on phrenology, then a fashionable and respectable science.

One of his most vigorous and persistent campaigns was waged to liberate American women from what he considered to be a medieval slave status. At a time when such views were fantastic — as early as 1831 — Neal lectured for the right of women to hold property, and to vote. And in 1843, he went so far as to suggest, in a lecture at the Broadway Tabernacle in New York, that the women of America had the right to revolt against an oppressive government, citing the Declaration of Independence as his authority.

At the age of 79, Neal collared a young man and pitched him out of a horse-car when the youth persisted in smoking in the presence of some lady passengers.

He died on June 21, 1876, in his 83rd year, a prophet with honor in his own home town but virtually forgotten everywhere else.

But local fame is not very durable. Recently I talked with an old resident of Portland, not a bookish man, but the kind of Yankee John Neal would have liked. Had he heard of Neal? He paused, reflected for a full minute, and then replied: "Didn't he write a guide book to Portland many years ago?"[2]

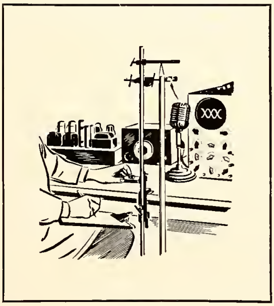
[2]**Portland Illustrated** (1874).

BUSINESS IN MOTION

To our Colleagues in American Business . . .

Most people think of brass tube as a mill product with a great many important industrial uses. It is regularly used to carry water and other liquids, to make parts of machines and appliances, railings, handles, and so on. Yet it also can be a musical item, in door chimes, and the story of its development for that purpose is an unusual one.

When electric door chimes appeared, it became evident that here was an entirely new requirement for brass tube—that it produce a pleasing tone when struck. The other factors that have made brass tube a staple, large-volume product for so many years, such as its rich color and corrosion resistance, dictated the choice of brass. Here, then, was the problem: what are the causes of pleasing tone in tube, and how can they be controlled in the mill in order to supply a reliably standard musical product?



The first step was purely experimental. Revere proceeded by ear. Over 100 samples of tubes in various alloys, tempers and gauges were hung up, struck, listened to, and preferences obtained from many people. These tests showed an outstanding preference for the tonal quality of one type of tube. But Revere did not stop there. It was desirable to know why that tone was preferred, what factors were responsible for it, and how they could be controlled.

The project then was turned over to a laboratory physicist who is also a talented musician. Now began the most ambitious and lengthy and scientific part of the work, employing the most modern electronic apparatus, including a beat-frequency oscillator and a cathode ray oscilloscope. These made it possible to dissect the tone produced, measuring the intensity and frequency of the fundamental note and its partials with an accuracy of one cycle per second. Much new information was developed concerning the source of the tone, the manner in which the tube vibrates, and the changes in the tone produced by changes in tube characteristics. The net result is that Revere really knows chime tube, scientifically, musically, physically, and, of course, how to produce it. We also know exactly how a chime tube should be plugged, and where struck, and why, which information is of value to door chime manufacturers.

As Revere contemplates the voluminous laboratory records of this work it realizes that interesting and important though it was, it is by no means a solitary example. Revere has repeatedly studied in the greatest detail both new and old applications of its mill products, and uncovered data of value in extending the life and usefulness of them. So, for that matter, has practically every other supplier of materials to industry. Hundreds of companies operate well-equipped, competently-staffed laboratories. Others employ college laboratories more or less steadily. The final results of these continuing studies are embodied in products and processes, and thus raise the standards of all American industry. In addition, in the majority of cases secrecy as to the information obtained is not imposed, and thus you can obtain not merely better products, but also much information of practical value in their use. It has been pointed out that those who pay for materials also pay for the brains required to develop them, and that therefore those brains should be used. Thus, Revere suggests that no matter what you buy, be it rubber or glass, chemicals or metals, cements or solvents, you would do well to draw upon the brains of your suppliers.

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

☆ ☆ ☆

Executive Offices:

230 Park Avenue, New York 17, N. Y.

Industry and Education

(Continued from page 15)
much of our basic technical information came from abroad. The remainder came largely from our own universities and a few industrial laboratories. Our stockpile of basic scientific knowledge was seriously depleted by the war; our normal supply of scientists and research engineers was likewise seriously depleted by the war. Both must be re-established.

Universities are deeply concerned about these problems. Normal funds are no longer adequate to educate an increased number of postgraduate students, to support an adequate amount of basic research, and to provide for a greatly expanded enrollment of undergraduates. Endowment income has scarcely kept pace. High taxes have made future endowments questionable. And, at the same time, costs of operation have increased all along the line. The growth and maintenance of American industry and future security of our country are imperiled by these critical shortages.

Again — a ready answer is to be found in more government spending for research. There is no doubt that the Federal government does have a responsibility for certain types of research. Weapons of war, public health, agriculture—these have long been recognized as governmental prerogatives. It seems inevitable, too, that the government must continue to expend large sums on military research in the years ahead.

Industrial research, however, is clearly a task for industry—either in its own laboratories or on a sponsorship basis in public service organizations created for that purpose. I firmly believe, too, that industry must accept a greater responsibility for the encouragement of fundamental research and for the training of research workers in universities.

A national science foundation bill was passed in the last session of Congress. It provided for the expenditure of government funds on fundamental research. And it provided undergraduate scholarships and graduate fellowships for promising science students. It was later vetoed by President Truman because of its administrative procedures.

The President's research advisory committee recently urged that such a foundation be established and that it be authorized to spend at least 250 million dollars a year by 1957 for basic research. The report further recommends that total national expenditures on research of all kinds should be at least 1 per cent of the annual national income by the same date. This is nearly twice the current rate.

Despite some very effective work in American universities under the sponsorship of government agencies, *I am opposed to government domination of fundamental research.*

Central direction of a large share

(Please turn to page 44)

(Continued from page 42)

of the country's scientific investigation is a dangerous procedure. Complete freedom of inquiry to explore all phases of scientific activity is essential for sound progress. Such freedom is difficult, if not impossible, to maintain even under the best possible centralized administration.

The alternative — or perhaps the antidote—to government domination of fundamental research is greater support from industry. As yet, industry has accepted this responsibility only on a small scale. About 200 companies support perhaps 1,000 fellowships in American colleges. Yet this is one of the most obvious ways of increasing knowledge and educating research workers.

Every company with scientific personnel could well afford to support fellowships of this kind. There are many good examples of individual company projects and many others of an industry-wide nature, but the practice needs great expansion. It has been proposed that tax credits be provided corporations which support fundamental research. A bill to put the proposal into effect was introduced in the last session of Congress. Such a plan has considerable merit. But the incentives for support of fundamental research should make it unnecessary.

How industry can cooperate with education

I have been discussing some of the broad relationships between industry, government, and education. I have attempted to point out the importance of a continuous supply of educated citizens and trained scientists. I have discussed the importance of fundamental and applied research to the security and prosperity of the nation. The need for broader educational opportunities for our most able youth has been mentioned.

There are certain specific areas of cooperation between industry and education which can help to bring about these things:

1. Cooperative programs in which students spend alternate periods on the job and in the class-

(Please turn to page 46)

(Continued from page 44)

room, thus combining practical experience with a sound theoretical training.** Many colleges maintain such programs. They offer the advantage of producing a graduate with a thorough understanding of industrial problems. Furthermore, they provide the financial resources for able young men otherwise unable to attend college.

2. Evening classes in metropolitan areas for persons employed in industry. Most colleges and universities in metropolitan areas conduct such classes. Participation by employees merits the encouragement of management, for such extra training increases the employee's usefulness to his organization and to society.

3. In-plant training programs and special courses to meet the needs of employees of a particular company. (Work of this type is illustrated by the program of graduate education conducted by Illinois Institute of Technology for engineers in the Allis-Chalmers plant in Milwaukee.)

4. Scholarships for undergraduate students and fellowships for graduate students. These help to identify young men of promise and encourage their education. (An outstanding example is the nation-wide competitive scholarship program of the Pepsi-Cola Company, which annually assists several hundred students from all states of the union.)

5. Greater direct support for fundamental research in universities.

6. Utilization of the services of university research foundations, by small companies as well as large. These programs help to solve specific problems in applied research. They make it possible for experienced personnel and extensive equipment to be put at the disposal of manufacturers at reasonable cost. (An example is Illinois Tech's Armour Research Foundation, which has worked with hundreds of companies on important research projects in the 10 years since its formation.)

7. Pooling of an industry's interest in graduate education and fundamental research. (An example is the Institute of Gas Technology at Illinois Tech.) Such organizations find the healthiest environment for their development in cooperation with colleges and universities.

Conclusion

I feel that the proper maintenance and growth of our system of higher education is of vital importance to every citizen. I feel with President George D. Stoddard of the University of Illinois that "the wealth of the state and the nation derives from the promise of youth." Industry in particular has a very special interest and a real responsibility for helping educational institutions find sound answers to some of the problems in education and research.

There are very great pressures — backed by persuasive reasoning—for greatly increased Federal support for both. Perhaps that is the only answer. But I am thoroughly convinced that greatly increased Federal support of education and research without a corresponding increase in support by industry and private philanthropy is another step toward collectivism. Centralized control inevitably accompanies centralized support. If you permit the government to supply all the money — through your own failure to do so—then you can expect government control of higher education and research.

Let us, rather, do our best to maintain independent action by individual initiative—a free partnership of science, industry, and education.

Technology's Heritage

(Continued from page 19)

pire? What were the consequences—political, social, moral—of these vast projects?

Western civilization was founded on the grandeur that was Rome, and the wealth of Rome increased a thousand fold with every generation. What else? Did speed of transport, rapidity of communication, increased productivity bring greater happiness to the millions of slaves and citizens of the Empire? Technology made possible both bread and circuses; did it lessen barbarity and conspicuous consumption? Were the skilled technicians merely the instruments of avarice and cruelty? Did the wealth they had created become a magnet to attract the hordes of the despoilers, the have-not Huns, Vandals, and Goths?

In more recent times, what has been the net result of England's enormous technical advances in industrial progress epitomized in Masefield's lines?

Dirty British coaster with salt-caked smoke stack,
Butting through the Channel in mad March days,
With a cargo of Tyne coal,
Road-rails, pig-lead,
Firewood, iron-ware, and cheap tin trays.

Will England, rebuilding her Empire on a South African axis, take into consideration the mistakes made in her technological era? Will we, in the United States, confronted by the technological failures of other civilizations, repeat the story of isolated greatness and material mastery and disappear amidst the ruins of skyscrapers, blasted roads, and twisted rails? The answer, it appears, rests in large degree with our engineers.

The engineer should know and understand how his skills have been employed in the cultural patterns of which he is a part. History is inclined to look upon some of the engineering marvels of the past as useless landmarks of unfunctional societies. Egyptian and Toltec pyramids, Sphinxes, obelisks, Mayan temples: monuments to pride and superstition built at enormous cost in manpower and wealth. Yet in their day such wonders were undoubtedly completely functional. The Toltec Sun and Moon pyramids and the massive temple to Quetzalcoatl at Teotihuacan were a part of a highly developed culture which had also built vast irrigation systems, devised a calendar as accurate as our own, and established a system of fair and equitable produce distribution. Who is to decide, a thousand years hence, whether a Rushmore monument, a Rockefeller Center, or silted-in Hudson River tunnel were functional or mere phases of a civilization that worshipped tradition, Rockefeller, and speed?

The technologist must learn, the hard way, perhaps, that much of his effort is expended on refining machines that may some day be as dead as the dodo. To what end does he employ his skills in perfecting the media for transmitting sound and picture?

(Please turn to page 50)

(Continued from page 48)

Examine the cultural forms that have resulted: mass participation in the vicarious thrills of radio serials, distorted news reports, and sensational motion pictures. Our printing presses, including the radio newspaper, can print faster but no better than the presses of the sixteenth century bookmakers. Speech and pictures cannot be made to travel faster than the electric impulses now employed to transmit them. A turbine cannot be made more than 100 per cent efficient. Subsidiary improvements are possible; atomic energy will provide new power to apply to old machines. Of course, the machines will be greatly modified and new ones, jet propelled, will be created. But the engineer is learning that the machine must serve, not dominate. He may discover, as Mumford tells us in *Technics and Civilization,* that "as social life becomes mature, the social unemployment of machines will become as marked as the present technological unemployment of men. . . . The machine, so far from being a sign in our present civilization of human power and order, is often an indication of ineptitude and social paralysis."

Engineers are in the saddle today; if they are to retain that position they must not employ whip and spur. A degree of arrogance can be detected in their general attitude: "Without us where would you be?" It is true, we would have no four-lane highways and highspeed motorcars, no streamlined, cross-continent Zephyrs or Rockets, no four-motored airborne Constellations, no skyscrapers, no deep-freeze units, no television sets, no high fidelity sound-wave mechanisms, no technicolor motion pictures, no soft lighting effects. On the other hand we would have no glaring neon lights, no soap operas, no cheap Westerns, no traffic congestion, no destructive forces to wipe out 100,000 persons in a single explosion. It is not an unmixed blessing that technology has brought us. No one wishes to go back to a horse and buggy era or to an age when apples and corn were dried in the sun on the woodshed roof. But the engineer is not the corn-fattened

(Please turn to page 52)

(Continued from page 50)

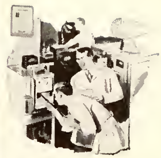
prize animal in the modern scene that he appears to be. A study of the history of technology would show him that he has his periods of power—history is measured by centuries—and his periods of eclipse. The Egyptian and Euphrates valley engineers had their day of ease; their irrigation systems, based on sound principles of hydraulics, were largely responsible for the rise of empires dependent on the vast supplies of food which they had made possible. What happened to those empires? No society has ever continued because of its engineers; no civilization is ever completely destroyed by other engineers. Survival depends upon the efforts of all sectors of society working toward goals determined by all sectors. Empires or civilizations collapse or decay after they have "survived and triumphed." America may top all previous civilizations in power and conquest; after that, the story of its engineering triumphs may be something for the archaeological angels, if there are such, to record. Technological history makes humble engineers. Professor W. H. Burr has said:

> "It is now largely a matter of speculation, how these ancient engineers planned and executed their works, but enough has already been disclosed to show that the modern engineer has not been the only engineer to meet and solve difficulties, or to make the best use of the means at his command to accomplish great engineering works."

National, world-wide, or interplanetary engineers, however, must go far beyond making "the best use of the means at his command to accomplish great engineering works"; they must, if they have studied technology's heritage, help engineer the universe as well.

THIS IS BENDIX

BENDIX is essentially a great creative engineering and manufacturing organization—unlike any other existing in America. ¶ Despite the fact of its modern manufacturing plants and its demonstrated productive capacities, the essence of Bendix greatness lies in its ten research laboratories and in the integrated knowledge its many engineers have jointly acquired in the fields of electronics, magnetics, optics, ceramics, electro-mechanics, hydraulics, pneumatics, injection-carburetion, aerological physics and metallurgy. ¶ Bendix is constantly exploring the widest possible application of all these sciences to all manner of industrial, commercial, domestic and human problems. ¶ By virtue of this, wherever machinery replaces human effort, there you will find Bendix instruments and controls lightening the load on human minds and removing the strain from human backs and hands. ¶ The searchlight of Bendix creative engineering is always pointed to a bright and better tomorrow. ¶ When you see the name *Bendix Aviation Corporation*, on any product, you can buy it with the definite knowledge that it is first in creative engineering design and the last word in quality.



"...TO A BRIGHT AND BETTER TOMORROW"

ON the walls of the great Bendix laboratories . . . in the offices of the huge Bendix engineering staff . . . over the desks of executives in Bendix plants the country over, there hangs an exact copy of the credo pictured above. It hangs there because it is a *working* credo—an authentic statement of Bendix aims, aspirations and accomplishments. The results of this wholehearted preoccupation with a finer future for you are everywhere apparent. Radio, meteorology, all forms of transportation aloft, afloat and ashore are better because of Bendix, and new products of basic importance to industry and individuals are constantly added. "To a bright and better tomorrow." Every Bendix Resource is dedicated to this purpose. . . . Look to Bendix for *your* future. In research, engineering and manufacturing, it's one of America's most versatile industrial organizations.

BENDIX PRODUCTS: automotive brakes, carburetors, landing gear • BENDIX RADIO*: radio, radar, television • ECLIPSE* MACHINE: starter drives, bicycle brakes • MARSHALL ECLIPSE*: brake lining • ZENITH*: carburetors • STROMBERG* aircraft carburetors, fuel injection • FRIEZ*: weather instruments and controls • PIONEER* flight instruments • ECLIPSE* aviation accessories • SCINTILLA*: aircraft ignition, diesel fuel injection • PACIFIC*: hydraulic systems • RED BANK*: dynamotors, inverters • BENDIX INTERNATIONAL: 30 Rockefeller Plaza, New York 20, N. Y., Cable "Bendixcorp" New York.*

Bendix
AVIATION CORPORATION

Contributors

(Continued from page 4)

His writing and editing experience includes newspaper work prior to and during the war. He joined the Illinois Tech staff in April 1947.

Mentor L. Williams is assistant professor of English at Illinois Tech. He received his bachelor's and master's degrees at the University of Washington and his doctorate at the University of Michigan. He was an instructor in high school English in the state of Washington from 1925 to 1928. He taught at the University of Idaho from 1928 to 1931, and at the University of Michigan from 1931 to 1945. In 1945-46 he served as visiting lecturer at Tulane university. He joined the staff of Illinois Tech in the fall of 1946. Dr. Williams' articles have been published in *College English, Michigan Quarterly Review, Michigan History, Inland Seas,* and *Philological Quarterly.*

Salary Scale Proposed For Engineers

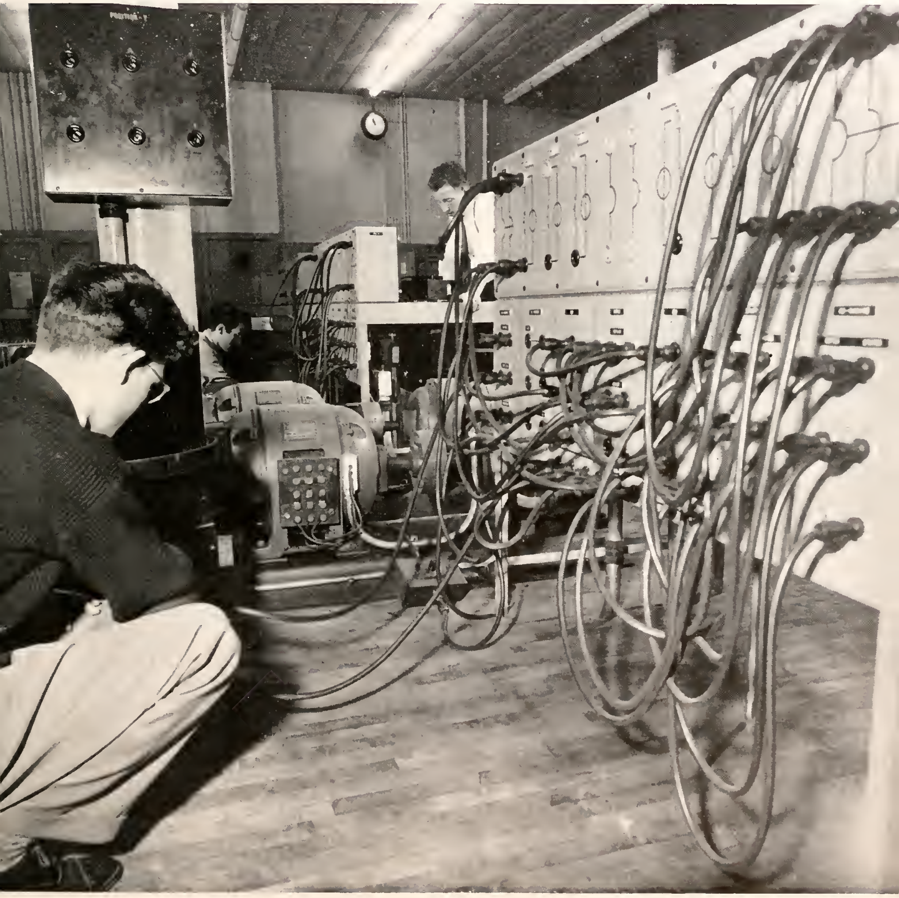
The Minnesota Association of Professional Engineers has proposed a series of minimum salary scales for engineers of that state.

The association would classify engineers in eight grades, two of which (Grades 1 and 2) would be considered pre-professional grades. Classification in the professional grades (Grades 3 through 8) is given those engineers who hold positions where considerable independent thought and action is required.

Minimum annual salaries (subject to a cost-of-living adjustment) proposed for Grades 1 and 2 are $2,640 and $3,400, respectively. Engineers in Grade 3, the lowest professional grade, would receive at least $4,200 annually. The minimum salary for Grade 8, the highest professional grade, would be $10,000.

A Grade 3 position might involve administration of the smallest city or county engineering organization. The Grade 8 classification would imply full responsibility as the head of a large engineering organization.

ILLINOIS TECH ENGINEER



MARCH, 1948

ALL OVER AMERICA... THE "CHOICE OF EXPERIENCE"!
More people are smoking CAMELS than ever before!
I SMOKED MANY DIFFERENT BRANDS AND COMPARED—IT'S CAMELS WITH ME!
I'VE TRIED OTHER BRANDS —NOTHING SUITS MY 'T-ZONE' LIKE A CAMEL!
CAMELS ARE THE 'CHOICE OF EXPERIENCE' WITH ME!
CAMELS SUIT ME BETTER ALL WAYS. THEY TASTE SO GOOD —THEY SMOKE SO MILD AND COOL!
Jerry Ambler
RODEO BRONC-RIDING STAR
Mrs. Dorothy Allan Newstead
HOLDER OF NATIONAL WOMEN'S FISHING RECORDS
Cecil Smith
INTERNATIONAL 10-GOAL POLO STAR
Mary Reilly
TABLE-TENNIS STAR
R. J. Reynolds Tobacco Company, Winston-Salem, N. C.
Let your "T-Zone" tell you why!
T for Taste... T for Throat... That's your proving ground for any cigarette. See if Camels don't suit your "T-Zone" to a "T."
CAMEL
TURKISH & DOMESTIC BLEND CIGARETTES
CHOICE QUALITY
● All over America, the story's the same! With smoker after smoker who has tried and compared different brands of cigarettes, Camels are the "Choice of Experience"!
Try Camels in your "T-Zone"—that's T for Taste and T for Throat—and you'll see why! Compare Camels for rich, full flavor; for mild, cool smoking—and you'll agree with the millions of smokers who say Camels suit them to a "T"! Let your *own* experience tell you why more people are smoking Camels than ever before!
According to a Nationwide survey:
MORE DOCTORS SMOKE CAMELS THAN ANY OTHER CIGARETTE
When 113,597 doctors from coast to coast were asked by three independent research organizations to name the cigarette they smoked, more doctors named Camel than any other brand!

Contributors . . .

Albert F. Heino, director of design, buildings, and airports for United Air Lines, was graduated at Armour Institute of Technology in 1926. He received a master's degree at the University of Illinois in 1928 and was an instructor in design at that school for two years. He opened an independent practice in Chicago in 1932. In 1942, Mr. Heino became head of the architectural department for United Air Lines and was placed in charge of research development covering requirements for airports of the future. He is a consultant to a number of cities on airport building programs, and is a member of numerous national and local committees on airport construction. He is chairman of the joint airline building commission for the new Chicago Municipal Airport terminal building and was the originator of the unit terminal plan for commercial air transport terminals. He is a director of the Chicago Chapter of the American Institute of Architects and has been awarded a medal of excellence by that organization.

Jesse E. Hobson, until March 1 director of Armour Research Foundation of Illinois Institute of Technology, now director of the Stanford University Research Institute, received his bachelor's and master's degrees at Purdue university in 1932 and 1933, respectively, and was awarded a doctorate (magna cum laude) at California Institute of Technology in 1935. From 1937 to 1941 he served as central station engineer for the Westinghouse Electric and Manufacturing company and as lecturer at the University of Pittsburgh. He became professor and director of the department of electrical engineering at Illinois Tech in 1941. Dr. Hobson was awarded Eta Kappa Nu's award to the outstanding young electrical engineer in the country in 1940.

(Please turn to page 4)

COVER PICTURE—Students in electrical engineering operate D-C generators in parallel.

VOLUME 13 NUMBER 3 MARCH, 1948

ILLINOIS TECH ENGINEER

In this issue

Published October, December, March and May.
Subscription rates, $1.50 per year.
Editorial and Business Office, Illinois Institute of Technology,
3300 Federal St., Chicago 16, Illinois.

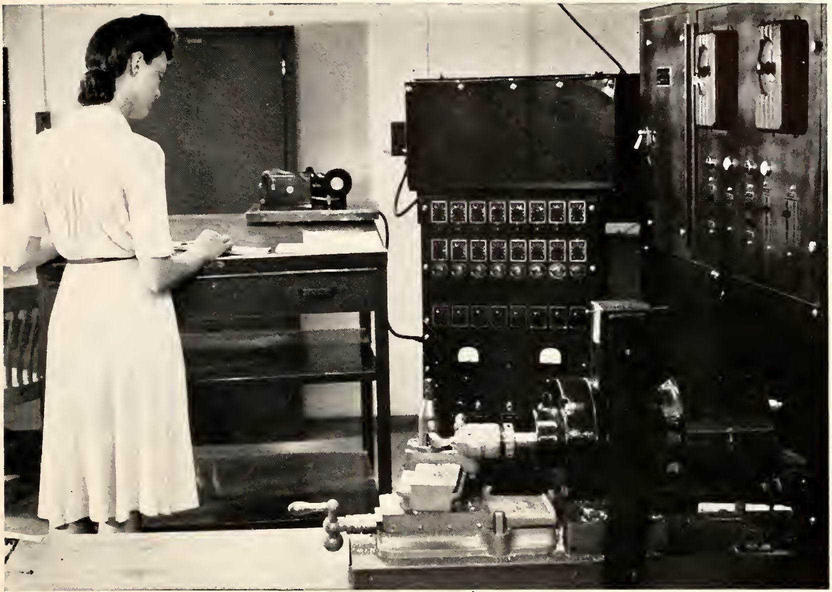
(Continued from page 3)

Karl Menger, professor of mathematics at Illinois Tech, has been a member of the faculty since September, 1946. Born in Vienna, he obtained his Ph.D. degree in 1924 at the University of Vienna. He taught two years at the University of Amsterdam, then 10 years at his alma mater. He gave visiting lectures in the United States in 1930-31 and came to this country in 1937 to join the faculty of the University of Notre Dame. He is the author of two books, *Theory of Dimension* (1928) and *Theory of Curves* (1932), and numerous technical articles both here and abroad.

Mary Louise Mojonnier, chairman of the department of home economics at Illinois Tech, was graduated at the University of Chicago in 1928 and received her master's degree at Columbia university in 1938. From 1928 to 1938, Miss Mojonnier taught at the Milwaukee Vocational school and was a nutritionist for the Infant Welfare Society of Chicago. From 1938 to 1946, she served as assistant director and, later, director of the home economics division of the department of welfare of the City of Chicago. She accepted her present position in 1946. Miss Mojonnier has held membership on a number of committees in the field of welfare, and from 1944 to 1946 was chairman of the Chicago Nutrition Association's Food Conservation Committee.

John Day Larkin has been dean of the Liberal Studies division at Illinois Tech since June, 1945. Previously he had been chairman of the department of political and social science. A graduate of Berea (Kentucky) College, Dr. Larkin received his master's degree at the University of Chicago and his Ph.D. at the Harvard School of Arts and Sciences, Harvard university. He has served on the faculties of Hamline university, the University of North Dakota, Harvard university, and the College of the City of New York. He

(Please turn to page 28)



Typical of its laboratory activities, Dow recently developed this direct-reading spectrometer that electronically measures concentration of elements in alloys—automatically records analyses in 40 seconds.

. . . the future of airports

by ALBERT F. HEINO*

A STRONG COMMERCIAL air transport industry is a national asset of the first magnitude. Without it, our nation would have been in serious difficulty in the early days of the last war when the government called upon the airlines for the skills and knowledge to assist in organizing the greatest air armada in history. The Air Transport Command and Naval Air Transport Service were aided by years of successful commercial operation, and the men who pioneered the airlines of the country became of inestimable value in creating the great world-wide air transport that helped win the war.

Our commercial air transport system, besides being closely related to any plan of national defense, bids well to play an important part in the economy of the nation in the years to come. We must recognize that the well being of all of the citizens of this country is dependent upon the position this country holds in the forward progress of the aeronautical sciences.

Prior to the war, and even up to this day, the major attention of the airlines has been directed toward the development of bigger and better aircraft. Economics has demanded that the aeronautical engineers develop aircraft capable of producing the maximum amount of revenue. High payload weight with safety has been the objective. In the process, wing loadings have been increased and larger and faster airplanes have resulted; both speed and magnificent safety records have been attained.

While all this has been going on, development of the nation's airports has, with few exceptions, lagged behind. Airports designed for aircraft of another day are suddenly found inadequate to handle modern transports and lacking in adaptability to flight procedures of the future, which promise all-weather landings and greater regularity of service. Not only are the majority of airfields unable to meet the requirements of modern aircraft, but what is worse, in many cases they cannot be expanded. Where it is possible, they are hemmed in by a multitude of obstructions which make safe approaches under all-weather conditions a matter of great concern and difficulty.

A good example of this situation is the Chicago Municipal Airport which, for many years and up to the war, was considered one of the finest airports in the country. It also is an excellent example of modification to meet the ever-increasing requirements of aircraft. The original field, comprising a quarter section, was laid out in 1926. Later, in 1930, it was expanded by the addition of another quarter section to the west. During the heyday of WPA, the Belt Railroad tracks were removed and the field doubled to bring it up to its present size of 620 acres. Tomorrow, its successor, Douglas Airport, will comprise approximately 6,000 acres.

Chicago Municipal is still a fair

* Director of design, buildings, and airports, United Air Lines.

airport for contact operation, but it is not adaptable to instrument landings and all-weather operation, the goals of the future. Expansion of the present Municipal to achieve these objectives is not feasible economically because hundreds of occupants of surrounding space would have to be displaced at great cost. Therefore, Chicago, along with other major cities of the country, has come to the realization that to provide properly for air transport of the future, it is mandatory that a new concept of airport design be adopted and that the necessary provisions be made to assure reasonable permanence and longevity of its major airport. The alternate to such an airport program is retrogression in the development of the nation's air transport industry and stabilization of aircraft design adaptable to pre-war airfields. This latter course could not produce an economically healthy air transportation system.

The primary objective of commercial air transportation is regularity and dependability of service with safety. The science of electronics, stimulated by wartime research, is playing its part in bringing about a gradual improvement in airline service. Today, a much greater percentage of scheduled flights are completed. And, with the full development of all-weather landing aids, service will be as regular and dependable as that of any surface carrier. Under present approach procedures, instrument landings are slow. At best, they are at the rate of approximately 20 movements per hour on a single runway airport, and until this operation is speeded up, no major airport presently conceived will be able to handle the traffic volume that is predicted.

The important thought in this connection is that, in our estimates of traffic capacity at a given airport, we should think in terms of regular operation under all-weather conditions. The practice in the past has been to schedule on a "contact operation" basis. When the weather closes in, disruptions in schedules occur and many thousands of passengers are discommoded. This happens because there is not sufficient airport capacity under adverse weather conditions to satisfy the normal travel demands of the public.

Planners of the super airports at Idlewild in New York and Douglas at Chicago have had to make certain assumptions that the projected traffic may some day be possible through improvements in the science of instrument operation of aircraft, as well as in the science of airways traffic control. The master plans for both of these airports are based on the assumption that 360 movements per hour under instrument operations will some day be a practical reality. Even though this reality is in the future, the gradual stage development of these airports will be planned to satisfy the traffic at a given time while providing for expansion when the projected traffic load materializes.

All this is good, particularly where the premium in dollars is not excessive for the attendant gains. In the past, few airports were built when the scale of the development of air transportation was evident. As a consequence, there was a notable lack of provision for future expansion. This has resulted in the obsolescence and abandonment of many expensive airports, which are just not usable for modern commercial air transportation. The remarks here refer principally to airports constructed in the twenties and to even those built in the period immediately preceding the war. During the war, many excellent airports were constructed for military purposes by the Government, and in many cases, these same airports now provide modern, well designed bases for commercial operation.

In development of an airport many interests have to be taken into consideration. No longer are airports built simply to serve as stopping places for commercial air transports. There is an awakening in the nation, a realization that the welfare of its citizens is inextricably a part of each and every project. Congress has recognized this fact in the passage of the National Airports Bill granting federal aid for airport development. The airlines provide the vehicles to take the business developed by its citizens in and out of a given city.

The cost of operation is of great concern to the general public as is the cost of the ground plant necessary to provide this service. Few people realize that the total investment in ground facilities is a small part of the business generated through this new form of transportation and that they and the air carriers are partners in the true sense of the word. The distribution of cost for both airline operation and the con-

AERIAL VIEW SHOWING RELATIVE LOCATION OF AIRPORTS

struction and maintenance of the fixed plant is the principal subject of negotiation today. Airport development is held back in some cases because of a failure to negotiate satisfactory terms. In other cases, the operation of airlines is restricted because of short sighted policies of governing bodies. The airlines themselves are not without blame in this respect and share the responsibility.

It is axiomatic that if we adopt the short-sighted policy requiring the airlines to pay the major portion of cost of the expensive ground plant, without regard to potential revenue from other sources, fares will be raised to such a level that the large ground plants projected would become unnecessary because of the resultant loss of market. The theory that the airlines should pay the bulk of costs can prove a deterrent of inestimable magnitude to business and industry in many cities. What is the answer?

Our country is the acknowledged leader in the field of aviation. We believe in it. We have built up the greatest air transportation system in the world. It is certain that this industry will go forward. It will be the principal medium in uniting peoples of the entire world. As speeds increase, it will become also an important means of communication. The traffic potential that may be generated is enormous and air travel will supplant many present day methods of doing business by slower and more cumbersome means.

If we accept all of this, then the problem is to find the equation that provides air transportation at the lowest possible cost for John Q. Citizen. After all contributing elements have been thoroughly recognized, it seems that the cost of passenger transportation should be relatively low so that it will be within reach of the greatest number of income levels. The burden of cost should be borne by commercial developments on the airport which benefit by air transportation. Cities, states, the federal government in all of its branches, and business in general all have important stakes in the larger problem and should all bear a relative percentage of the cost commensurate with the advantages to each.

When the Port of New York Authority proposed to spend $191,000,000 for the development of the New York airports in addition to approximately $90,000,000 already spent by the city, an economic problem was created. Obviously, a revenue picture had to balance this capital cost. Where was this revenue to come from? The size of the project in dollars is a substantial portion of the invested capital of the entire commercial air transportation industry.

The Port immediately set about to create an aviation center on a regional basis and Idlewild and LaGuardia became major business enterprises. It was acknowledged that the commercial airlines could not be expected to contribute the major share of the total revenue. Nonairline revenue became the principal object of study for this huge investment; every avenue of approach was taken. The project was scaled up and down in an attempt to justify the economic picture in each stage of development.

The Port recognizes that one of the easiest ways to break the back of the airline industry is to saddle it with unbearable costs. At the same time, being a sound and progressive business organization, the Port must justify its investments to its bond holders. From the Port of New York and airline studies in the New York area should come some interesting data which may help chart the course for future development elsewhere.

Last year, 18,500,000 passengers were flown on the domestic airlines,

and the crystal gazers tell us that 50,000,000 passengers will be flown in 1960. In the last pre-war year, 1940, 2,800,000 passengers were flown. A quick look at these figures impresses one with the seriousness and magnitude of the problem:

How can the present traffic, already much greater than in pre-war years, be handled now, and what must be done now to prepare for the accommodations necessary to satisfy the traffic of 1960?

All kinds of goods and services must be provided in addition to the basic transportation needs of these people. Airports will become social centers and will symbolize the degree of participation of a given community in the aviation pattern. A pressing need is for larger and improved passenger station facilities. A rapidly growing part of the industry is air freight. It will not be long before air freight terminals will be centers of major activity at airports. Congress has under consideration a program to provide post offices on airports. This may presage the carrying of almost all first-class mail by air and the installation of an air parcel post service. Such developments would bring more traffic to airports and greatly increase the building needs.

Wise planning demands decentralization of the principal elements which make up the ground plant of an airport. Since we do not actually know the picture of the future, we can ill-afford to build all-purpose buildings which are not easily expanded or used for purposes other than those for which they were designed. Initial cost may be slightly higher where this philosophy is used, but it will pay dividends in the facility of expansion and the elimination of congestion at unpredictable dates in the future. Certainly our experience in the past has shown this to be true. It is less costly to plan intelligently than to be expedient in satisfying the needs of the hour without regard to what happens when conditions change.

Leaders in the field advocate decentralized and modular planning, simplicity of form and construction, and low capital cost structures. The architecture of the age of flight should bear some relationship to the age it will typify. Monumental airport architecture should be relegated to the past where it belongs and not be resurrected when an attempt is made to express a dynamic and progressive industry. The architectural and engineering professions will be most helpful if they will make maximum use of light construction and new building methods and materials. Here is an opportunity to create an architecture that is truly American; planners should bear this in mind when urged to fall back on architectural idioms of the past.

An airport passenger station, usually referred to as the "terminal building," should be a highly functional structure. It contains, besides the public areas, an integral part of the nerve system of the airline. There is no need to house this type of activity in monumental high cost buildings. We must approach passenger station design with the same cold economic analysis that is applied to an apartment building, a department store, or any other business structure.

The facilities that are planned for the convenience and use of the general public as well as for airline passengers and which are of a non-airline category should carry the cost of buildings to house them, plus a sufficient bonus to the city (preferably based on activity and volume) to contribute to the general good of the airport. Facilities built strictly for airline operation and containing operational offices should, as stated above, be simple in construction with low first cost and should be subject to complete amortization by airlines using them. We will run into trouble when the air carriers are called upon to assist in carrying the burden of high building costs, the primary use of which is non-airline.

It must be recognized that the design of a passenger station to serve air transportation differs from that to serve surface transportation. Fundamentally, the problem is the same, but the physical characteristics of the airplane introduce problems in circulation not usually present to the same degree in the design of a railroad or bus terminal. Actually, the analogy is more nearly to that of a series of docks on the waterfront.

It is generally agreed that the space required to dock one plane is 150 lineal feet. Seven of these are necessary to handle the passenger capacity of a single average railroad train. In other words, where large traffic is to be handled, the problem
(Please turn to page 26)

Airport scenes such as this taken at New York's LaGuardia Field emphasize the immensity of modern airliners. The plane above is 100½ feet long, has a wing spand of 117½ feet, and carries 52 passengers plus 6,000 pounds of cargo on one-stop coast-to-coast schedules.

TRENDS

in

Industrial Research—I*

by JESSE E. HOBSON†

Application of basic scientific knowledge, through applied or industrial research, to the problems of industry and government was given great impetus during the war when applied research laboratories succeeded in meeting the national emergency. Postwar needs for technological developments are only a degree less urgent, and we find both industry and government engaged in large-scale programs of scientific activity. Research, both basic and applied, has become a major resource. Viewed in any light—expenditures, manpower, contribution to the nation's economy, contribution to national security, or promotion of general welfare — research has become big business and a major profession.

Research In Industry

INCREASED LABOR COSTS and higher taxes, plus increased competition between industries and between companies within an industry, are causing more emphasis to be placed on the application of scientific knowledge for the development of new products and processes, reduction of production and service costs, and improvement of the quality of existing products. Last year brought a marked expansion of investment by industry in industrial research in existing laboratories, in the development of new laboratories, and in research "farmed out" to independent laboratories and to universities.

The National Research Council reports 133,515 persons now employed in more than 2450 laboratories of industry, an increase of almost 100% over the total personnel of 70,000 reported in 1940. The rapid increase in the number of laboratories and laboratory personnel since 1915 indicates a long term trend. In 1915 there were only 100 such laboratories. Five years later there were 300, employing 9300 persons. By 1939, 34,000 persons were employed in 1625 laboratories.

Included in the present total of 133,515 are 55,000 professional per-

Dr. Hobson is shown at his desk with a model of the continuous belt recording machine. The machine was designed by Marvin Camras of Armour Research Foundation and developed by the Mast Developing Company, Davenport, Iowa.

* This article and a succeeding one in the May issue of the *Illinois Tech Engineer* will appear in the forthcoming *International Industry Yearbook*, edited by Lloyd Hughletf and published by McGraw-Hill International Company.

† Until March 1, director of Armour Research Foundation of Illinois Institute of Technology, now director of the Stanford University Research Institute.

sons, as compared with 35,000 in 1940. A smaller percentage increase of professional personnel than total personnel is an indication of the growing shortage of scientists and engineers, particularly those with advanced training.

According to the National Research Council, professional personnel in the laboratories of industry are distributed among the branches of science as follows:

Chemists, 21,095; biologists, 1,695; engineers, 20,637; doctors of medicine, 236; physicists, 2,660; metallurgists, 2,364; psychologists, 22; geologists, 81; not classified, 5,567.

Although John R. Steelman[1] estimates the annual expenditures for research by industry at $450 million, others are inclined to place the probable expenditures nearer $600 million or $700 million. In any event, expenditures have increased about 100% since 1940. A recent survey by the Patents and Research Committee of the National Association of Manufacturers disclosed that anticipated expenditures by the Association's members for 1947 will be 270% above 1939 and 14% above 1946. Several companies reported that their 1947 research and development budgets will be more than 10 times their expenditures in 1939. Research programs are carried on by 750 of the 983 companies covered by the NAM survey. Replies further indicated an average ratio of research investment to gross sales for 1947 of 1.6%, as compared with 1.86% for 1939.

Business Record[2] reports that the median percentage of the sales dollar spent on research falls between 1½% and 2%, with some companies spending as much as 5% and a very small minority allocating little or nothing to research and development. This survey also shows that most companies report a higher percentage of the sales dollar spent on research and development than before the war; and it points out that, whereas the ratio may be the same as or below the prewar rate, aggregate research expenditures in many instances show a sharp rise over 1939 and 1940.

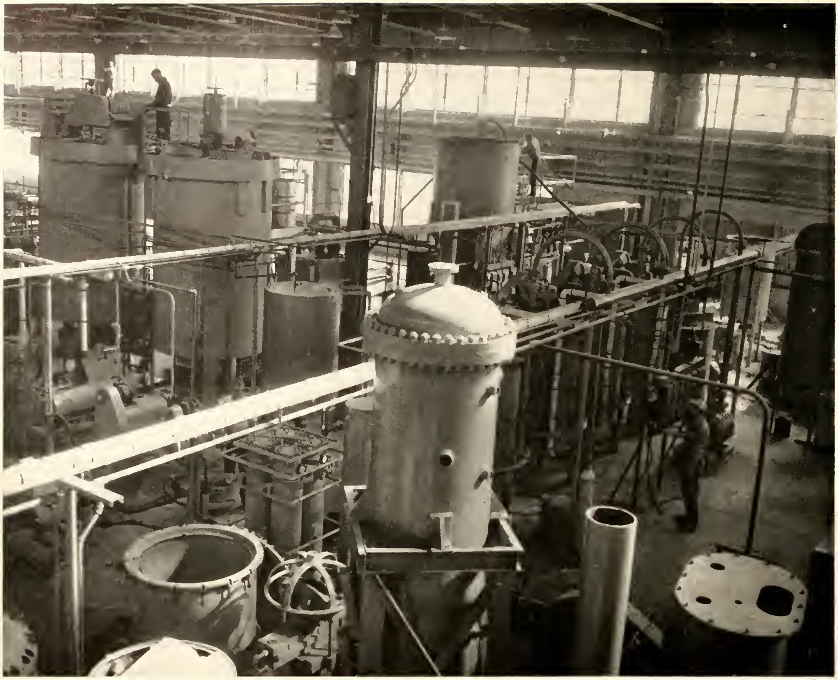
(This point is illustrated by the record of a railroad equipment company which showed 1.1% of sales spent on research both in 1946 and 1939, but with total expenditures in 1946 amounting to $852,000 as compared with $273,000 in 1939, a gain of 212%.)

The top picture shows the first building completed at the new Johns-Manville research center located 40 miles from New York City. This unit is 572 feet long. Pictured also is an artist's sketch of the new Merck research building now nearing completion in Rahway, N. J.

A survey on the "Research Requirements of American Industry" by the Evans Research and Development Corporation concludes that 87.1% of industry as a whole is spending more for research than in the prewar period, 10.6% the same as in the prewar period, and only 2.3% spends less than in the prewar period. Further, 86.1% of all industries benefited from their wartime research activities. It is significant that 72.5% expect to increase their research activities in the future and that 60% expect to expand their facilities. From one to two years is needed before industrial research can be brought to the desired level, according to 45% of the reporting industries.

The same survey reveals that 47.6% of industry invests funds in research to improve present products

[1] **In his Report to the President,** *Science and Public Policy.*
[2] **"A Survey of Business Practices," March, 1947.**



The pilot plant for research on manufacture of industrial insulations recently unveiled at the new Johns-Manville research center.

and processes, 42.3% to develop new products and processes in their own fields, and 14.7% to develop products and processes in other fields.

Barrons National Business and Financial Weekly[3] states as examples of current expenditures for research:

"The American Cyanamid Company . . . spent almost $7 million in 1945; six years before it spent less than $2 million. The Bendix Aviation Corporation presents an even more striking picture. Its research and engineering expenses for 1945 were approximately $18 million as contrasted with a 1939 figure of $2.5 million. International Business Machines Corporation more than doubled its prewar budget of $1 million. Addressograph-Multigraph, Monsanto Chemical, Westvaco Products, American Smelting and Refining, Allis-Chalmers and a host of others had like stories to tell. The figures vary, but the principle remains the same:

"These corporations all regard money spent for research as a definite investment and are pouring more funds into it, as they would into any investment that has proved its profitability."

No one can accurately predict the future budgets for research by industry. One thing, however, is certain: industrial budgets for research not only will increase but *must* increase if American industry is to keep its place as world leader and maintain its position in world trade. Some research leaders have predicted research expenditures will double within the next 10 years. If this occurs, research by industry alone will exceed one billion dollars.

Certain factors inevitably will increase the costs of industrial research and perhaps decelerate an extension of the rapid growth of the past several years. The shortage of trained scientists and engineers created by wartime reduction of college training certainly will increase research salaries. Many scientific problems can be solved now only with the use of intricate and expensive scientific equipment and through the cooperative efforts of research teams trained in several fields.

Furthermore, the cost of produc-

(Please turn to page 30)

[3] Feb. 17, 1947, article by Robert M. Bleiberg.

[4] Italics ours.

Fundamental and Applied

RESEARCH IN GEOMETRY

by KARL MENGER*

MUCH HAS BEEN SAID and written about the relations between fundamental and applied research. Geometry supplies us with examples for almost any expected and unexpected contingency.

There was, for instance, the purely theoretical question as to whether or not a certain geometrical proposition could be logically derived from other propositions—and eventually the research about this question led to modern Cosmology (Part I). If this application is not "earthly" enough, there were the purely theoretical speculations about miniature planes containing only a finite number of points; and these speculations resulted in methods of testing fertilizers in agricultural experiments (Part II). There are, on the other hand, examples of the fact that sufficiently profound research on applied problems occasionally opens wider theoretical vistas than visionless theoretical studies. The geometrical consequences of Kirchhoff's theory of electrical networks in what is called the "topology of graphs" illustrate this fact (Part III). Whatever their relations to geometry, stars and fertilizers and currents belong to the physical universe. In order to complete the picture we add a few remarks about graphs in the social universe of tastes and voluntary decisions. We outline an application of geometrical thinking to the famous ethical principle known as the categorical imperative (Part IV).

Need we say that our general remarks might be confirmed by numerous other facts? Our selection has been prompted by the idea of presenting to the readers of this journal topics of research in the field of pure geometry carried on at Illinois Institute of Technology.

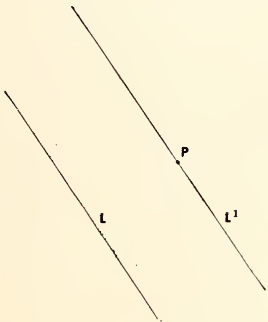


Figure 1.

I. Parallel Lines And Cosmology

In his "Elements," Euclid developed a large part of geometry from postulates which he enumerated at the beginning of his book. One of the most outstanding features of the famous work was the fact that Euclid derived imposingly many and complicated conclusions from astoundingly few and simple assumptions—so much from so little that geometers became over-exacting. They tried to derive from Euclid's other assumptions the only postulate which was somewhat complicated: namely, the parallel postulate. According to this postulate, for a given line *1* and a point *P* not on *1*, the plane determined by *1* and *P* contains exactly one line that passes through *P* and has no point in common with *1*. This line (the line *1'* in Fig. 1) is called the parallel to *1* through *P*. The unsuccessful efforts to derive this parallel postulate from Euclid's other assumptions constitute the greater part of the geometrical activity during the 2000 years following the publication of Euclid's "Elements".

It was only at the beginning of the 19th century that the truth dawned on geometers: namely, that the parallel postulate could not be derived from Euclid's other assumptions. And even before this fact was rigorously established, two geometers, Bolyai and Lobachevsky, began the actual development of a theory based on an assumption that contradicted Euclid's parallel postulate. They started with the hypothesis that for a given line *1* and a point *P* not on *1*, the plane determined by *1* and *P* contains more than one line passing through *P* and not intersecting *1*. Certainly this latter assumption is valid on a sheet of paper, or in the rectangle of Fig. 2 where we can draw many lines through *P*, such as *l'*, *m*, and *n* which *inside the rectangle* have no common point with *1*. The system of consequences of Bolyai's and Lobachevsky's parallel postulate in conjunction with Euclid's other assumptions is called Non-Euclidean Geometry.

It cannot be stressed enough that this non-euclidean geometry started as a purely intellectual game. As was mentioned above, at first even the logical consistency of the game was doubtful; for, as long as there was

* Professor of mathematics, Illinois Institute of Technology.

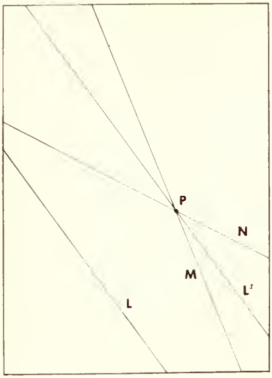


Figure 2.

a possibility of proving Euclid's parallel postulate from his other assumptions, the non-euclidean geometry was threatened by the danger of contradiction. But around 1870, Beltrami and Klein precluded the possibility of Euclid's postulate ever being proved. Their method consists in exhibiting objects of the Euclidean plane which satisfy all the assumptions that Bolyai and Lobachevsky made about points and lines in the non-euclidean plane. Every contradiction derived from these latter assumptions would thus constitute a contradiction in the theory of some objects in the euclidean plane. These Beltrami-Klein objects are the points and lines in a bounded piece of the euclidean plane such as the rectangle of Fig. 2, the only difference being that, for technical reasons, a circular or elliptic domain rather than a rectangle is chosen.

The geometry of Bolyai and Lobachevsky was followed by other non-euclidean geometries which deviated from euclidean in other respects. Riemann was the first to develop a general theory which included Euclid's geometry along with a large number of non-euclidean geometries. For over half a century his research remained buried in the journals on pure mathematics; and, even in the realm of pure mathematics, it occupied a corner that seemed to be particularly remote from possible applications.

During this entire period, applications of geometry were based entirely on Euclid's "Elements." The reason was that Euclid's assumptions were extrapolations to space "in the large" of observations concerning chalk dots and lines on a blackboard, and concerning little particles and certain rigid rods.

In the second decade of our century the situation was changed by the general theory of relativity. At the foundation of this theory are the assumptions: that cross hairs in telescopes and light rays behave like points and lines in a general geometry such as that studied by Riemann; that their more specific properties and relations vary from one region of the space to another; and that in each region these relations depend upon the distribution of masses in that region. In elaborating on these ideas, Einstein and his collaborators unearthed the work of geometers done during the preceding century and brought it from its remote corner into the center of interest to physicists, astronomers, and cosmologists. It is hardly an overstatement to say that the development of the theory of relativity and modern cosmology would have been retarded by many decades had geometers not prepared non-euclidean geometries, developed purely for the sake of their intellectual interest.

After the Beltrami-Klein proof of the fact that non-euclidean geometry is logically as consistent as euclidean, and after the application of non-euclidean geometry to Nature, philosophers with pro-euclidean prejudices had to withdraw to the rather vague position that euclidean geometry is simpler than any non-euclidean geometry, and, besides that it is the only intuitive theory of space.

A new theory of the Bolyai and Lobachevsky space, developed by the author and his collaborators during the last decade, seems to indicate that, quite to the contrary, this non-euclidean geometry is simpler than euclidean. For the new development of the geometry of Bolyai and Lobachevsky is based entirely on a few simple assumptions about the operations of joining points and intersecting lines, while mere assumptions about joining points and intersecting lines (or even about the arrangement of points on lines and in planes) can never supply us with a complete foundation for euclidean geometry. In fact, it can be proved that a complete postulational theory of the euclidean space must be based on assumptions about congruency or perpendicularity[1].

On several occasions during the past few years we have pointed out that the visual space is non-euclidean. What we see at a given moment is just one half of a euclidean space, viz., the half before us. What we see of the floor on which we stand is one half of a euclidean plane. The visible part can be obtained by deleting from the entire plane a line and all points on one side of this line in the same way as a non-euclidean plane can be obtained by deleting from the euclidean plane an ellipse and all points outside of this ellipse. The analogy becomes even stronger if we notice that both ellipse and straight line are conic sections, the former being a degenerate section. For this reason we have called the visual space a degenerate non-euclidean or semi-euclidean space.

In concluding, we may point out that at present one of the greatest problems of geometry seems to be the development of new ideas (probably statistical ideas) concerning the properties of space "in the small". For while non-euclidean geometries have modified and generalized Euclid's extrapolation of blackboard conditions to the large we still cling to his extrapolation of these conditions to the small[2]. If geometers had the leisure to follow their purely intellectual impulses in this direction, the results could be applied to psy-

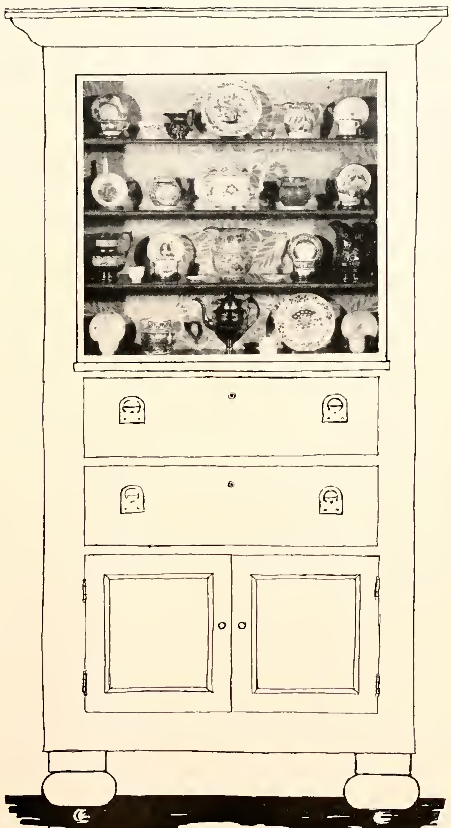
(Please turn to page 38)

[1] The same is true for the spherical as well as the so-called elliptic geometry so that among the classical geometries, that of Bolyai and Lobachevsky rather than that of Euclid enjoys a unique simplicity.

[2] An attempt to replace geometry "in the small" by a statistical theory is to be found in the author's note in *Proc. Nat. Acad. Science*, 28, (1942) p. 535.

Profession: Homemaker

by MARY LOUISE MOJONNIER*



A SOCIETY CAN BE only as strong as are the homes of which it is composed. Upon the character of these depends the welfare of the community and ultimately of the nation. The need for satisfying homes and family relationships is greater at present than ever before. The press today is filled with shocking stories of juvenile delinquency, crime, and frustration—a result of the failure of American men and women to establish and maintain homes that meet the fundamental needs of family members. The proportion of dependency and delinquency associated with broken homes is overwhelming.

There is within every individual a need for security and for affection that can be satisfied by belonging to and being an integral part of a group, by giving and receiving affection, and by the certain knowledge that one is necessary to the happiness of other human beings. Normally, this fundamental emotional need is met in the home where the child is secure in the affection of his parents and siblings. From this small circle, his acquaintances increase and he is able to relate himself to others and to society because of a satisfying experience in his family relationships. It is axiomatic in human relationships that one gives as he has received and that he is unable to give to others unless he has received from others a like kind and amount of affection and understanding.

The home is also an educational institution where the child learns, in addition to an enormous amount of fundamental information, the attitudes and habits that serve him helpfully or harmfully throughout life. Nor is education in the home confined to the young child. Throughout childhood one learns from his home environment and particularly from the other family members. Adults may also learn, from one another and from their children, to live together harmoniously, to share joys and disappointments, and to build a sense of family solidarity which in-

* Chairman of the department of home economics, Illinois Institute of Technology.

Students in interior design are taught the effective use of color, line, and texture in interior decoration.

fluences their contribution to the community.

Homemaking claims the time of more women than any other occupation. That it is a profession is too little understood today, for a home does not just happen; it has to be created. Successful homemaking requires times, effort, and specialized skills and knowledge, plus constant attention to the maintenance of standards of performance and continued study to keep abreast of late developments. A home, of course, does not consist only of the material things that make a house, nor of the organization that makes it run smoothly, but it consists also of the warm human relationships which serve to bring about happy family life. A practice of the knowledge and skills that produce the atmosphere and satisfaction of a home constitutes the profession of homemaking.

Home economics, which is essentially training for the profession of homemaking, is based on the philosophy that education can definitely bring about improvement in home and family life. Homemaking may be practiced by the person in one's own home or in an institution which is a temporary or substitute home for its inmates, or by influencing others to improve their homes. Teaching in home economics is not confined to the classroom, but it also extends to community education through health and welfare agencies, and to the business field. Many professional workers in home economics specialize in certain fields, but the contribution in each fiield is toward the common goal of improved home and family living.

Home economics, as a field of education, grew from the conviction of early leaders that the application of science to home problems could greatly improve the physical aspects of the home, that the application of art principles could enhance the aesthetic satisfaction derived from home surroundings, and that the application of social sciences could strengthen family economic practices and human relationships. This study has changed in the last 50 years as these three fields of fundamental knowledge have expanded. It now includes a study of all aspects of family living —material, economic, and social.

Fields Of Home Economics

At Illinois Institute of Technology a general home economics curriculum is offered. Some specialization is possible, but this is limited to the junior and senior years when electives may be chosen according to the student's interest. No specialized bachelors degrees are granted. This practice results from the philosophy that undergraduate training should be built on a broad base and that specialization should be confined to the graduate level. The home economics fields studied in the undergraduate courses are foods, nutrition, equipment, textiles, clothing, related art, child development, family economics, and family relationships. Because home economics is concerned with the application of principles from other fields, the course of study requires at least introductory courses in mathematics, chemistry, physics, physiology, economics, psychology, and sociology. Students are encouraged to go beyond requirments in these fields when their interests so dictate.

In foods and nutrition, one studies food in relation to social, economic, and nutritional needs, the chemical composition of foods, and the effect of various types of preparation on each. From this study, principles of cookery are developed which enable the student to modify recipes, and to develop new ones as the occasion arises. One becomes acquainted with commercial methods of food processing and studies the effect of each on the cost, flavor, and nutritive value of the product. Common methods of home food preservation and safe methods of food handling to avoid contamination are taught. Cost,

(Please turn to page 48)

The Challenge To Freedom

by JOHN DAY LARKIN*

WE MIGHT FIRST ASK, what are those features of our civilization which have given rise to our liberties—our personal freedom. There are many, of course. But I should like to stress at least *two* forces which seem to me to have been vital factors in advancing Western civilization—and especially its contribution to personal freedom. I choose these two because I believe them to be most vital, and perhaps the most likely to figure in our future way of life. First in point of time, if not otherwise, is religion—with us largely the Christian religion; and second, the growth of science and technology. Both of these have been tremendous factors in the evolution of Western civilization. And both have made unmistakable contributions to our so-called democratic way of life.

In considering Christian religion as being a major factor in the advancement of Western democracy (and the freedom which is such an essential factor in democracy) we should have it clearly understood that our reference is to the teachings of Christ—and the religion which such teachings engender and not necessarily to *the* Church, or any church. Churches are human institutions, subject to the frailties of those human characters who run them. Generally they have been important factors in the promotion of religion. But not always. At certain times and places churches have lent their power and prestige to reaction, to the promotion of slavery, to serfdom, to tyranny, and to all manner of unchristian objectives. But the religion of the brotherhood of man — the very foundation of freedom and democracy—is the factor of which we speak. In short, Western democracy emerged from a profoundly religious civilization. Whether or not it could have grown from irreligious roots, the fact remains that it did not do so.

At two turning points in English history Christianity played a decisive part. In the eighteenth century John Wesley broke away from the narrow Anglicanism of his day and took the gospel to the poor. His reforms led to the tremendous expansion of the Nonconformists or free churches, which in turn decisively influenced the beginnings of many liberal forces in Britain. And again, during the nineteenth century, waves of reform sponsored by Christian leaders swept over Britain—reaching into the prisons, the galleys, the mines, the factories and the workhouses. Most of these reform movements ultimately found expression in acts of Parliament in the interest of human rights.[1]

The history of this country is replete with comparable chapters inspired by religious leaders. The first colonists founded societies so thoroughly religious that some of them were practically theocracies. The drafters of the Declaration of Independence, and of the Bill of Rights in our Constitution, may not have all been Christians—in fact we know that some were not professed of that faith—yet both documents breathe the spirit of the natural law and of a divine order which were also the bedrocks of European political and religious thought. The pioneer women, who promoted "law and order" on our frontiers, based their championship of both on the faith they had in Christianity. And at the greatest crisis of this country's history, its deeply religious feeling found expression in Abraham Lincoln—a man without active affiliation with any church, but who is universally regarded as one of the most Christian statesmen the world has ever known.

No one will deny the strength of the other forces that have molded America, but the strength of the Christian strand is so formidable that those who wish to prove it immaterial to the development of democracy will not be able to produce historical data to support their contentions. The answer of history is irrefutable. Democracy and religion have so far been inseparable. And,

(Please turn to page 52)

* Dean of the Division of Liberal Studies, Illinoise Institute of Technology. "The Challenge to Freedom" was delivered by Dr. Larkin in Curtiss Hall of the Fine Arts building, Chicago, on January 29, 1948, as the first of a series of lectures sponsored by the Illinois Tech Alumni Association.

[1] Barbara Ward, "Christianity and Human Rights," *Atlantic Monthly*, December 1947, pp. 38-41.

Partners in Research*

ARMOUR RESEARCH FOUNDATION of Illinois Institute of Technology has just completed its eleventh year as an active partner of industry and government in the all important field of industrial research. Coordination of personnel and facilities,—pooling of knowledge and experience,—and wholehearted cooperation by and with industry and government have once again permitted it to make a significant contribution to the economic and technological wealth and strength of the United States.

During the past year, more than 200 sponsors of industrial research utilized the specialized staff of scientists, engineers and technicians and extensive equipment and facilities available to them under the *Armour Plan for Industrial Research.*

The soundness of this partnership is substantiated by the increasing research demands made upon the Foundation and its continued growth. Operating expenditures for the coming year are expected to exceed three million dollars. Expansion in operations and facilities and in staff improvement, described in detail later, has more than kept pace with the rapid increase of applied research.

The year has been highlighted by a broader and more effective research service to our sponsors and by an expanding sphere of influence and prestige for the Foundation.

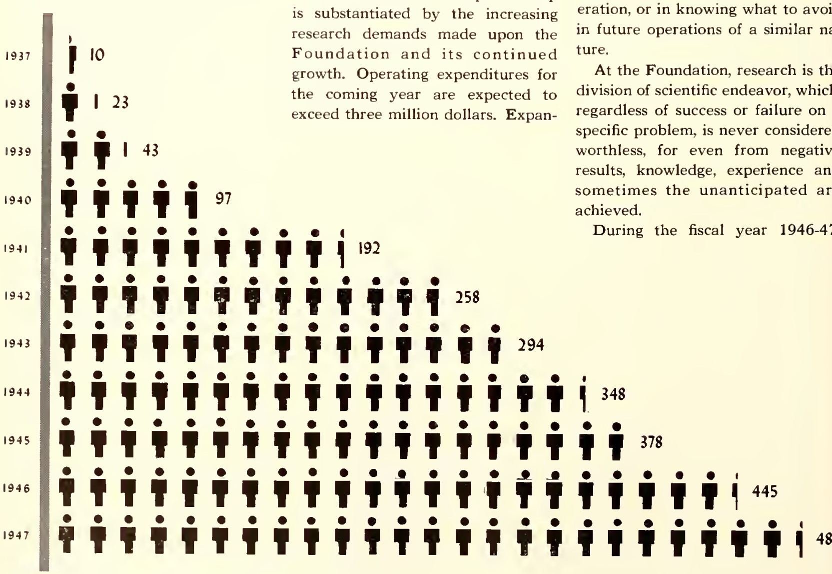
The Foundation is at work to provide technical information, and the problems as presented by industry and government become its problems. Their close and deep understanding of the problems at hand is invaluable, and their suggestions and observations during the prosecution of the various research projects have been guideposts in bringing these problems to a conclusion satisfactory to all.

Although a conclusion satisfactory to the sponsor and to ourselves is an ultimate goal, situations not previously contemplated sometimes develop. However, in research every move is valuable, either in gaining more knowledge of creation and operation, or in knowing what to avoid in future operations of a similar nature.

At the Foundation, research is the division of scientific endeavor, which, regardless of success or failure on a specific problem, is never considered worthless, for even from negative results, knowledge, experience and sometimes the unanticipated are achieved.

During the fiscal year 1946-47,

* Extracted from the Annual Report of Armour Research Foundation of Illinois Institute of Technology.



Personnel at Armour Research Foundation, 1936-1947.

there were 214 active industrial research projects. At the beginning of this fiscal year, the staff engaged in research on 105 active projects. Of these, 42 were active one year ago; 63 are new projects; 86 of those active a year ago were terminated or are now inactive, and 23 projects were both started and completed during the year.

Personnel

As of September 1, 1947, the staff of the Foundation totaled 488. This is an increase of 43 persons over the staff at the close of the 1945-46 fiscal year. Thirty-one of the new members are technical people. A breakdown of the staff shows:

	Technical	*Non-Technical*
Administrative	5	7
Magnetic Recorder Division	3	2
International Division	4	—
Research Division		
Ceramics and Minerals	11	—
Chemistry and Chemical Engineering	44	—
Electrical Engineering	20	—
Applied Mechanics	73	—
Mechanical Engineering	67	—
Metals	31	—
Physics	41	—
General Consultants	23	—
Business Staff	—	17
Clerical Staff	—	46
Research Services	—	71
Maintenance	—	19
Miscellaneous	—	4
Total 488	322	166

A further analysis of the 322 members of the technical staff shows that 12.5 per cent were occupied with scientific or technical supervision; 59 per cent consisted of research scientists and engineers; and 28.5 per cent were classed as technical and scientific assistants.

The prestige of an organization such as the Foundation depends to a large degree upon the individual staff members, their publications, patents, and participation in technical societies.

During the past year, staff members published 45 technical papers, two scientific books, and presented 83 technical talks. Twenty-one patents were filed or are in preparation for filing in behalf of our sponsors. Twenty patents were issued to the Foundation and its staff members, not including those for our sponsors. Sixty-nine patent disclosures not pertaining to research projects were submitted. Of these 32 were turned back to the inventor; 24 were recommended for research projects, either by the Foundation or by outside sponsors, and 13 are under consideration by the patent committee.

Technical seminars in the fields of acoustics, vibrations, power systems engineering, design, electronics, mechanics of solids, and others are maintained regularly by the staff. The staff has been active in affairs of professional and technical societies, both in Chicago and in national organizations.

In addition to staff additions, personnel improvement was brought about during the year by further educational activities of staff members. In all, 134 members of the technical staff enrolled in 172 courses, all except five of which were at the Illinois Institute of Technology.

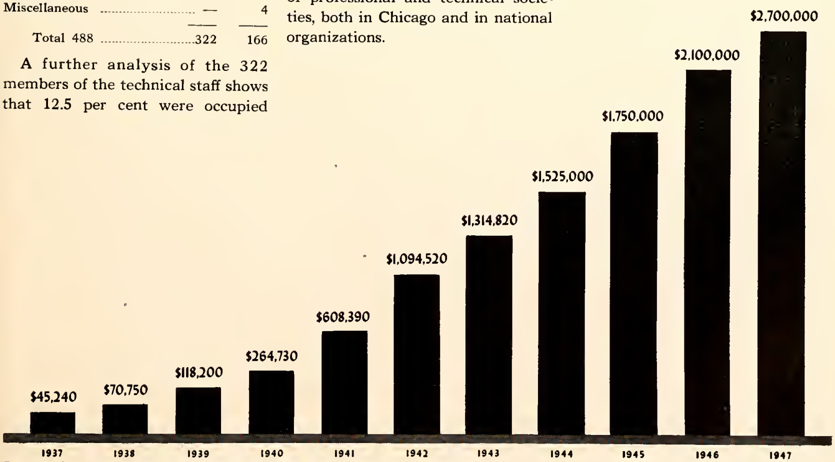
Financial Summary

The Foundation has just completed the largest annual volume of research business in its history.

Year after year our annual research volume has reflected a very significant increase in sponsored research projects. However, gross research volume for the fiscal years 1946-47 was in excess of $2,550,000 —an increase of 34.6 per cent over research volume for the previous year. This represents the greatest increase in gross research volume in the entire history of the Foundation.

Government Projects

The character of the work we are continuing to undertake for the armed forces and various other government agencies is becoming steadily more desirable from a research



Research Volume at Armour Research Foundation, 1936-1947

Distribution of companies sponsoring research activities.

point of view; and in most cases, in an effective manner supplements our research program for industry and increases our store of knowledge and experience.

It is the overall policy of the Foundation to render all possible assistance to research for military security, for public health, and for the development of our natural resources. However, at the same time, we must recognize our primary objective as being one of service to industry and, therefore, must keep the major portion of our facilities and personnel available for industry.

In keeping with this Foundation policy, government sponsored research was held to a reasonable percentage of our total business.

Research Division

Applied Mechanics

Reorganization of the Mechanics group during the past year resulted in the merging of the Fluid Mechanics Division with the Solids Mechanics Division, and changing the title of the combined group to "Applied Mechanics Research."

Perhaps the most significant change in organization of this department has been the establishment of close cooperation between Applied Mechanics Research at the Foundation and the Department of Mechanics at Illinois Institute of Technology. This was accomplished by naming a common chairman for both departments and establishing a Fundamental Mechanics Research Section which can utilize personnel from both departments and accept research problems from both. This merger, together with the inception of the Fundamental Mechanics Research Section, has resulted in a more coordinated research group with a substantial increase in personnel.

Ceramics and Minerals

The end of this fiscal year marked the completion of the first full year of operation of Ceramics and Minerals Research. This group was first set up as a separate department in March, 1946. The research volume of the department has shown a steady increase, with a current volume approximately 50% greater than that of a year ago.

Chemistry and Chemical Engineering

Chemistry and Chemical Engineering Research continued to render an outstanding service to industry during the past year. A Fine Particles Laboratory has been added to the number of special services maintained by the department, such as the National Registry of Rare Chemicals and the Dust Analysis Laboratory.

Several important equipment additions were made during the past year. The effectiveness of the plastics section has been increased by the addition of a plastic molding machine. This acquisition will prove of great benefit in reducing laboratory research to commercial practice.

Other important additions are a test chamber providing wide variations in humidity and temperature, an infrared spectrophotometer and a polarograph. A separate laboratory has been equipped with modern air-conditioning to provide a humidity and temperature-controlled dust-free room for studies in absorption spectroscopy and chemical microscopy. Petroleum research facilities have

been expanded and improved.

Electrical Engineering

The laboratory facilities and equipment of the Electrical Engineering Research department were improved considerably, thus allowing more efficient prosecution of industrial and fundamental projects. The AC Network Calculator was used a total of 238 days in the solution of power system problems. Plans are being developed to use the Calculator on studies other than power system problems.

The Ohmite Laboratory facilities were expanded during the year. This laboratory was quite useful on several projects and was of service to a number of industrial concerns for standardization purposes. Plans for the coming year include an extension of Ohmite Laboratory facilities to higher frequencies.

Mechanical Engineering

During the year, the equipment and physical plant of this department have been considerably improved. The year was marked by continued expansion of both personnel and facilities in order to provide a broader service to industry. A substantial quantity of much needed equipment was acquired, adding to both capital equipment and instrumentation. The availability of additional new floor space made it possible to increase the efficiency of this department by consolidating its personnel, laboratories, and activities.

Metals

This research group has expanded steadily both in personnel and facilities. Important personnel changes and additions have resulted in thoroughly strengthening the department. Equipment acquired during the past year has provided additional types of facilities in welding, induction heating, and heat treating. Prior to this year, Metals already possessed substantially complete facilities in fields of metallurgical research, namely: foundry processes, electrochemistry, powder metallurgy and metal working.

The additional facilities have necessitated the rearrangement of some of the equipment and the subsequent establishment of intergrated working centers for each of the seven Metals Research activities. Plans are developing for providing some additional floor area, and work is under way for the installation of new transformers and power lines to serve the new equipment.

Physics

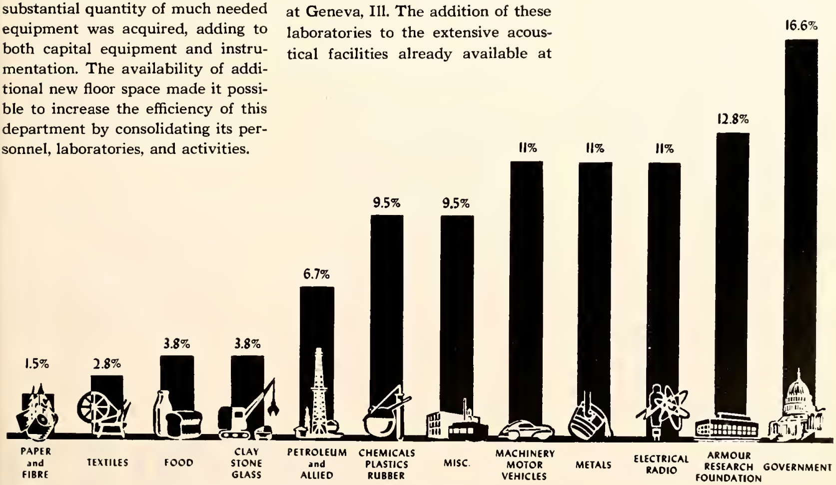
The organization of Physics Research has been expanded to include the direction and operation of Riverbank Acoustical Laboratories located at Geneva, Ill. The addition of these laboratories to the extensive acoustical facilities already available at the Foundation now makes it possible to handle practically any type of research program in the acoustical field.

The acquisition of a number of major items of equipment, including an optical bench, an infrared spectograph, and two 75-ton hydraulic presses, has added materially to the Physics Research facilities. The consolidation of the magnetic recording research program has been affected by the provision of additional space in a separate building.

Industrial projects and research for other departments continued at approximately the same level as last year. It should be noted that about one-fifth of the time of the Physics staff was spent on projects for other departments in keeping with the Armour Plan for Industrial Research. It is expected that this situation will continue, since the fundamental equipment available in Physics is useful on many reasearch programs carried on by other departments.

International Division

This division was established during the year with the purpose of *(Please turn to page 58)*



Distribution of sponsored research projects by types of industry.

Midwest POWER

The Midwest Power Conference, revived and reorganized in 1938, is sponsored by Illinois Institute of Technology with the cooperation of the following midwestern schools and local and national societies:

Iowa State College, Michigan State College, Northwestern University, Purdue University, State University of Iowa, University of Illinois, University of Michigan, University of Minnesota, University of Wisconsin, Chicago section of the American Institute of Chemical Engineers, Chicago section of American Institute of Electrical Engineers, Chicago section of American Institute of Mining and Metallurgical Engineers, Chicago section of American Society of Mechanical Engineers, Illinois section of American Society of Civil Engineers, Illinois chapter of American Society of Heating and Ventilating Engineers, Western Society of Engineers, Engineers' Society of Milwaukee, and National Association of Power Engineers.

Invitations are extended to all persons interested in power production, transmission, or consumption. Stanton E. Winston, dean of the evening division and professor of mechanical engineering at Illinois Tech, is the conference director.

Final Program
Tenth Annual Meeting

April 7-8-9, 1948

Sheraton Hotel, Chicago

Wednesday, April 7, 1948

8:30 A. M. Registration, Sheraton Hotel.

10:00 A. M. Opening Meeting. Chairmain: Henry T. Heald, President, Illinois Institute of Technology.

(a) Address of Welcome. D. D. Ewing, Head, School of Electrical Engineering, Purdue University.
(b) Estimates of Future Electric-Power Needs of the United States. F. R. Benedict, Manager, Industry Engineering Dept., Westinghouse Electric Corporation, East Pittsburgh.
(c) Flood Control and Power in the Southwest. Edwin Vennard, Vice President, Middle West Service Co., Chicago.
(d) The Trek of Industry Westward. John M. Drabelle, Chief Mechanical and Electrical Engineer, Iowa Electric Light and Power Co., Cedar Rapids, Iowa.

12:15 P. M. Joint Luncheon with A.S.M.E. Chairman: Robert Krause, Chairman, Chicago Sect., A.S.M.E.

Speaker: F. H. Thorne, Vice President, National Aluminate Corp., Chicago. "A Man's Reach."

2:00 P. M. Central Station Practice.* Chairman: R. B. Gutekunst, Chairman, Power & Fuels Div., Chicago, Sect., A.S.M.E.

(Sponsored and arranged by the Power and Fuels Div., Chicago Section, A.S.M.E.)
(a) A New Appraisal of the Fuel Situation. John Van Brunt, Vice President in Charge of Engineering, Combustion Engineering Co., New York.

2:00 P. M. Developments in Heating. Chairman: William Goodman, Illinois Institute of Technology.

(a) A Simplified Panel Heating Design Procedure, B. F. Raber and F. W. Hutchinson, Dept. of Mechanical Engineering, University of California.
(b) Comparative Performance of Panel and Convection Systems in Research Residence. S. Konzo and R. W. Roose, Dept. of Mechnical Engineering, University of Illinois.

* A short discussion is included at the end of each technical session.

3:30 P. M. Diesel Power. Chairman: John W. Andeen, University of Minnesota.

(a) Combustion in Diesel Engines. Otto Uyehara and P. S. Myers, Dept. of Mechanical Engineering, University of Wisconsin.
(b) A Test Cell for Measuring Engine Noise. W. P. Green, Dept. of Mechanical Engineering, Illinois Institute of Technology.

3:30 P. M. Electrical Measurements. Chairman: F. D. Weeks, Chairman, Industrial Group, Chicago Sect., A.I.E.E.

(Sponsored and arranged by the Industrial Group, Chicago Sect., A.I.E.E.)
(a) Electrical Measurement of Nonelectrical Quantities. Everett S. Lee, Engineer, General Engineering and Consulting Lab., General Electric Co., Schenectady, N. Y.
(b) Measurement of Power and Power Factor in Industrial Plants. Erwin Boland, General Electric Co., West Lynn, Mass.
(c) D.C. High Power Distribution Systems, Short Circuit Analysis. William Deans, Chief Engineer, I.T.E. Circuit Breaker Co., Philadelphia.

3:30 P. M. Power Plant Equipment and Appraisal. Chairman: Norman A. Parker, University of Illinois.

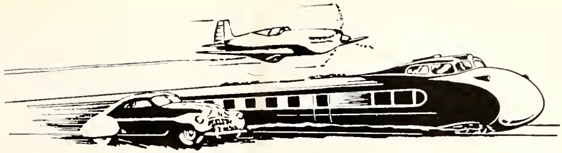
(a) Selection of Mechanical Draft Fans. A. P. Darlington, Head, Mechanical Draft Div., American Blower Corp., Detroit.
(b) Steam Power Plant Appraisal. Harry F. Lowe, Sloan, Cook & Lowe, Consulting Engineers, Chicago.
(c) Condensers, Their Use and Application in Water-Shortage Areas. R. J. Martin, Dept. of Mechanical Engineering, University of Illinois.

Thursday, April 8, 1948

9:00 A. M. Feedwater Treatment No. 1. Chairman: Ben G. Elliott, University of Wisconsin.

(a) Causes and Prevention of Condensate-Return-Line Corrosion. R. T. Hanlon, Special Service Engineer, National Aluminate Corp., Chicago.
(b) The Practical Approach to Modern Boiler Water Treatment. R. C. Ulmer, Technical Director, E. F. Drew & Co., New York.

9:00 A. M. Excitation Systems. Chairman: R. W. Watson, Westinghouse Electric Corp.



(a) Excitation Requirements and Control of Reactive Power. W. A. Lewis, Illinois Institute of Technology.
(b) Rotating Regulator Excitors. C. Lynn, Manager, D. C. Engineering Dept., Westinghouse Electric Corp., East Pittsburgh.

10:30 A. M. Hydro Power. Chairman: W. A. Lewis, Illinois Institute of Technology.

(a) Japanese Electric Power System. E. J. Burger, Vice President and Division Manager, Ohio Public Service Co., Lorain, Ohio.
(b) Sediment Transportation in Streams in Relation to Power Plant Operation. M. C. Boyer, Research Engineer, Iowa Institute of Hydraulic Research, State University of Iowa.

10:30 A. M. Locomotive Power Units. Chairman: D. D. Ewing, Purdue University.

(a) The Coal-Fired Gas-Turbine Locomotive. P. R. Broadley, Mechanical Engineer, Central Railroad Co. of N. J., on loan as Ass't. to Director of Research, Locomotive Development Committee, Baltimore.
(b) The Diesel Electric Locomotive. J. E. Goodwin, Chief Mechanical Officer, Chicago and Northwestern Railway System, Chicago.

12:15 P. M. Joint Luncheon with A.I.E.E. Chairman: Jesse E. Hobson, Chairman, Chicago Sect., A.I.E.E.

Speaker: A. C. Monteith, Manager, Headquarters Engineering, Westinghouse Electric Corp., East Pittsburgh. "Opportunities in the Power Field."

2:00 P. M. Rural Electrification. Chairman: T. O. Millard, Chairman, Power Group, Chicago Sect., A.I.E.E.

(Sponsored and arranged by the Power Group, Chicago Sect., A.I.E.E.)

(a) Rural Electrification from the Power Company Viewpoint. Grover C. Neff, President, Wisconsin Power & Light Co., Madison.
(b) European vs. American Distribution in Towns & Rural Areas. K. R. Brown, Brown Engineering Co., Des Moines, Iowa.
(c) Application of Oil Reclosures on Distribution Systems. R. O. Askey, Public Service Co. of Northern Illinois and C. V. Miller, Joslyn Mfg. and Supply Co., Chicago.

2:00 P. M. Power Plant Operator Training. Chairman: Joseph P. Flynn, President, National Association of Power Engineers.

(Sponsored and arranged by the N.A.P.E.)
Speakers:
Kenneth R. Hodges, Editor, National Engineer, Chicago.
Julius Barbour, East Lansing, Mich.
Garrett Burgess, Detroit, Mich.
Stephen C. Casteel, East St. Louis, Ill.

3:30 P. M. General Power Systems. Chairman: E. B. Kurtz, State University of Iowa.

(a) The Foreign Power Situation. Walker L. Cisler, Chief Engineer of Power Plants, Detroit Edison Co.
(b) Power System Stability, E. W. Kimbark, Dept. of Electrical Engineering, Northwestern University.

3:30 P. M. Industrial Power Plants. Chairman: M. P. Cleghorn, Iowa State College.

(a) Furnace Design Methods, With or Without Water Walls. Ollison Craig, Riley Stoker Corp., Worcester, Mass.
(b) Application of Heat Balance Analysis to Industrial Plants. H. C. Carroll, Commercial Testing and Engineering Co., Chicago.
(c) Experience with a Multiple Fuel-Fired Water-Tube Boiler. R. Frank Hollis, General Superintendent, Alton Box Board Co., Alton, Ill.

6:45 P. M. "All Engineers" Dinner. Informal. Grand Ball Room. (Ladies Invited).

Toastmaster: Alex D. Bailey, Vice President, Commonwealth Edison Co., Chicago.
Speaker: Colonel Robert R. McCormick, Editor and Publisher, Chicago Tribune.

Friday, April 9, 1948

9:00 A. M. The Heat Pump. Chairman: R. A. Budenholzer, Illinois Institute of Technology.

(a) Heat Source Possibilities of the Earth, (Milwaukee Area Heat-Pump Study). Charles H. Randolph, Air Conditioning Engineer, and O. O. Wagley, Superintendent of Industrial Sales, Wisconsin Electric Power Co., Milwaukee.
(b) Investigation of the Heat Pump for the Chicago Area. M. S. Oldacre, Director of Research, Utilities Research Commission, Chicago.

9:00 A. M. Feedwater Treatment No. 2. L. G. Miller, Michigan State College.

(a) Use of High Alkalinity & Organic Materials for Sludge Removal in H-P Boilers. Selden K. Adkins, Chemist, Omaha Public Power Dist., Omaha, Neb.
(b) Recent Developments in Boiler Water Research. F. G. Straub, Research Professor in Chemical Engineering, University of Illinois.

10:30 A. M. Power and Control. Chairman: A. H. Wing, Chairman, Electronics Group, Chicago Sect., A.I.E.E.

(Sponsored and arranged by the Electronics Group, Chicago Sect., A.I.E.E.)

(a) Circuit Principles of Industrial Electronic Control. Walther Richter, Allis-Chalmers Manufacturing Co., Milwaukee.
(b) Rectifier Power Supplies from D-C Systems. C. R. Marcum, Westinghouse Electric Corp., East Pittsburgh.
(c) Electronically Controlled Motor Drives. Marvin M. Morack, Power Electronics Div., General Electric Co., Schenectady, N. Y.

10:30 A. M. Fuels and Combustion. Chairman: R. Clay Porter, University of Michigan.

(a) Experiment on Underground Gasification in the United States. W. C. Schroeder, Chief, Office of Synthetic Liquid Fuels, Bureau of Mines, Washington, D. C.
(b) Possibilities of Coal Processing in Power Production. A. D. Singh, President, Singh Co., Chicago.

12:15 P. M. Joint Luncheon with W.S.E. Chairman: William V. Kahler, President, Western Society of Engineers.

Speaker: Charles E. Friley, President, Iowa State College. "Research and Social Progress."

2:00 P. M. General Session. Chairman: Herman Halperin, Chairman, Civic Committee, Western Society of Engineers.

(Sponsored and arranged by the W.S.E.)
Subject: The Engineer in Civic Affairs.

(Please turn to page 67)

CONFERENCE

VOCATIONAL INTERE

ALL NEW STUDENTS entering Illinois Institute of Technology complete, as a part of their orientation test, the Kuder *Preference Record.* This inventory is designed to measure the vocational preferences or interests of the individual, and to furnish a ready and objective indication of the type of activity in which he would probably achieve the greatest satisfaction.

The *Preference Record* consists of 168 items, each of which presents three kinds of activity. The individual marks the answer sheet in such a way that he indicates the one which he would most prefer, and the one he would least prefer. An example of the type of item[1] used is:

X. Visit a museum of science
Y. Visit an advertising agency
Z. Visit a factory in which typewriters are made

or this:

G. Test various brands of products for a co-operative store to see which are best
H. Take care of the bulletin boards in a large business organization
J. Keep accounting machines in good order

The response to any specific item is of little importance. The inventory is scored to reveal patterns of interest built upon the cumulative answers to all the items which fall in a particular field. Interest is measured in nine areas: mechanical, computational, scientific, persuasive, artistic, literary, musical, social service, and clerical. Here again, we are concerned less with the score in any single area than with the profile formed by the pattern of scores in the nine areas.

These areas are self-explanatory with the exception, perhaps of persuasive and social service. The persuasive score is obtained from items involving highly verbal, direct contact with others, in such occupations as salesman, actor, counselor, labor leader, and the like. The social service score is obtained from items involving activities with others in a service or therapeutic relationship, as personnel director, clergyman, physician, Y.M.C.A. secretary, and other similar occupations. None of the areas have any significant relation to intelligence or other general or specific abilities.

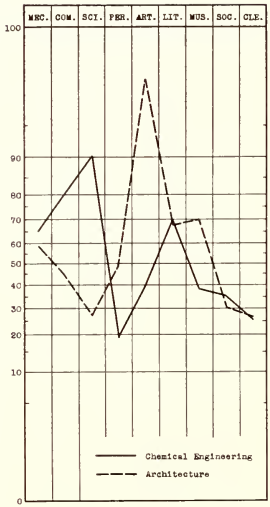


Figure 1. Percentile rank of mean *Preference Record* scores of 110 chemical engineering freshmen and 61 architecture freshmen.

These interest scores, along with the various ability and aptitude test scores, are furnished to each counselor at Illinois Institute of Technology, so that the freshman student has an appraisal of his interests as well as his ability. Thus, with the counselor, he may plan his career more wisely, selecting the curriculum to which he appears best adapted.

Experience has indicated that there are significant differences in vocational interest between students entering engineering studies and those entering non-engineering studies. There are also significant differences between students entering different fields of specialization in engineering. These differences are important in the guidance of the student, for it is a basic assumption in the measurement of interests that where ability, opportunity, and effort are equal, the individual will achieve the greatest satisfaction and success

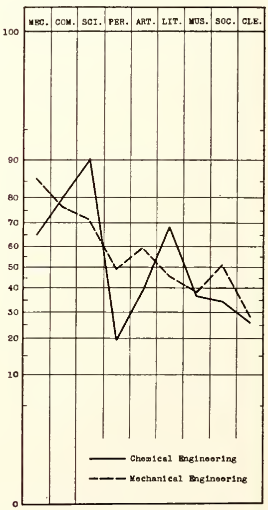


Figure 2. Percentile rank of mean *Preference Record* scores of 110 chemical engineering freshmen and 252 mechanical engineering freshmen.

* Director of the Institute for Psychological Services of Illinois Institute of Technology.

[1] Copyright, 1944, by G. F. Kuder, Quoted by permission of Science Research Associates, publisher.

Fire Protection Engineers

by GEORGE S. SPEER*

in the area where he has the greatest interest.

In Figure 1 are shown the percentile ranks of the mean scores obtained by freshmen entering chemical engineering and freshmen entering architecture. It is quite apparent that the students in the two groups have sharply differentiated interests. The interest patterns of freshmen chemical engineers may be compared also with the mechanical engineering freshmen, as shown in Figure 2, and the fire protection engineers as shown in Figure 3.

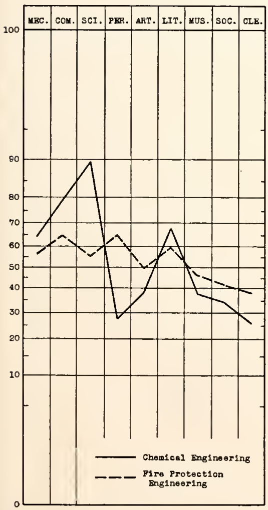


Figure 3. Percentile rank of mean *Preference Record* scores of 110 chemical engineering freshmen and 34 fire protection engineering freshmen.

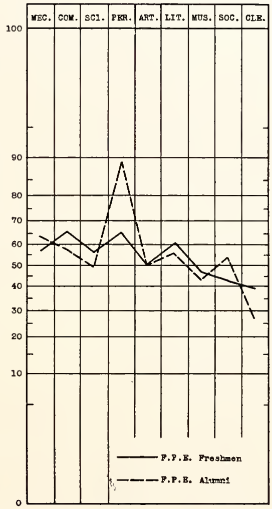


Figure 4. Percentile rank of mean *Preference Record* scores of 34 fire protection engineering freshmen and 116 fire protection engineering alumni.

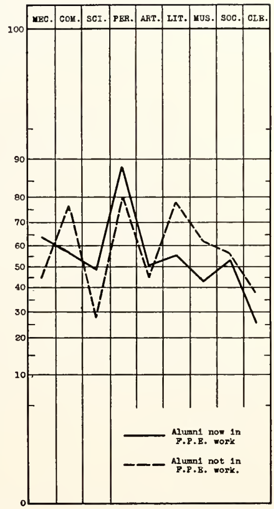
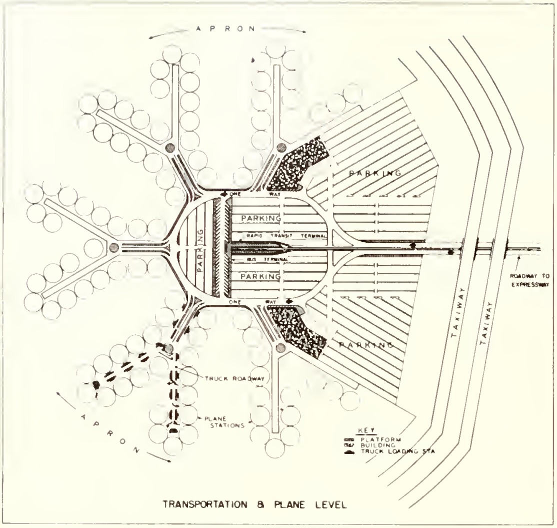


Figure 5. Percentile ranks of mean *Preference Record* scores of fire protection engineering alumni who continue and those who change.

Our studies of over one thousand freshmen at Illinois Institute of Technology indicate characteristic and significant profiles for all of the various groups. The fire protecting engineering freshman, however, has a profile which differs from that of other groups primarily because there is no area on which marked interest is exhibited by the group. As Figure 3 shows, the profile for the fire protection engineering group is a rather flat one, whereas other engineering groups, and the non-engineering groups such as architecture, have definite peaks and valleys in the profiles which indicate strong and characteristic interests.

A possible explanation of this lack of a distinctive profile is that fire protection engineering students are a more heterogeneous group than students in the other departments. That is, the fire protection engineering group may include students who are attracted to the curriculum as a step

(Please turn to page 68)



The plan for the Chicago Orchard (Douglas) Airport. An artist's sketch of airport is shown on page 7.

. . . the future of airports

(Continued from page 9)

of circulation for both passengers and cargo becomes the major consideration. It is further emphasized when we realize that speed is the greatest asset of air transportation and that it can, to a large extent, be minimized by excessive ground time. Therefore, in the approach to airport terminal design, traffic engineering problems come first and must be solved satisfactorily or other fine features of the terminal will not develop to the fullest extent.

You will notice in the illustration showing the proposed scheme for the passenger facilities at Douglas Airport that the total traffic is broken down into five sub-terminals. This design is the result of many studies covering the range from maximum decentralization to maximum concentration and represents a compromise wherein maximum non-airline revenue may be located reasonably close to the operating sections of the terminal.

It should be pointed out that the ideal terminal from an operating standpoint is not necessarily the ideal solution because there must be an integration of the operating units of the terminal with the maximum development of facilities of a non-airline nature to serve the general public in addition to patrons of the airlines. Balance of these primary functions of the building is necessary and a sacrifice of one for the other can result in an uneconomical solution. Generally speaking, maximum centralization places the greatest handicap on airline operation and maximum decentralization places a handicap on facilities for non-airline revenue.

The solution of the economic problem under discussion determines to a great extent the kind of facilities that may be created at a given city. High unit building costs and an attempt to extract high airline rentals will cause a contraction of building plans to a point where the ultimate objective is entirely lost. Contrary to this extreme, maximum play for non-airline revenue can create a carnival with air transportation as a side show. Certainly this would not be a desirable situation. There is a common sense, middle ground.

The kind of development that takes place on a given airport is largely dependent upon the airline operating requirements and the resources, both civic and industrial, of the city itself. Certain airports become maintenance bases for airlines and require large developments of shops, hangars, administrative offices, and so forth. Generally speaking, these maintenance and overhaul bases are located at the end of the line, which permits flexibility in the scheduling of aircraft and allows maximum utilization of airplane payload time. The major maintenance base of United Air Lines at San Francisco carries out this thinking.

Airline service requirements at airports fall into three categories: (1) storage and minor service, (2) service hangars which perform up to major maintenance checks, and (3) repair, overhaul and engine change.

Most airports served by commercial airlines have hangars available for minor repairs except for large aircraft. In some cases, nose hangars, wherein only the engines and the nose of the ship are under cover, are employed. To date, the principal use of storage hangars has been to perform minor repairs and irregular maintenance on aircraft, particularly to put an airplane under cover to warm up the engines after a period of idleness during schedule interruptions.

The second category involves more elaborate servicing facilities which will allow work on an airplane while on jacks. This type of hangar will be used for major maintenance checks which are performed on all aircraft on or before every 150 hours in the air. In addition to the hangars, approximately an equal amount by area of shop and office space is necessary. These facilities are likely to be found at division points and

(Please turn to page 28)

(Continued from page 26)

intermediate stations where terminating schedules occur. For instance, it is advantageous to have complete servicing facilities where an airline desires to balance the utilization of aircraft in either direction. If weather interferes with scheduling, ships can be serviced and dispatched in the opposite direction. Such a major service station for United Air Lines is located at Chicago. It is an important point on United's system because it permits flexibility in the routing of aircraft to obtain maximum flying hours out of each plane.

The third category is the most elaborate of all. In addition to greater hangar requirements, what amounts to an aircraft factory is necessary. Here, after a normal engine overhaul period, usually about 1,000 hours, the airplane is completely overhauled and, after processing is, in effect, a new plane. United has recently completed its new base in San Francisco which is the most modern maintenance base in the world.

In addition to the airline servicing requirements, airports must furnish accommodations for other flying activities. Fixed base operators provide a source of revenue where the commercial air activity does not command full utilization of the airport. Such activities as airplane sales and service for private airplanes, charter service, sight-seeing local aircraft, aeronautical schools, plane storage, plane rentals, fuel sale and service may become integrated into the overall aviation facilities.

As indicated above, extensive and independent air freight terminals will become necessary as this new business develops. To date, much of the air freight activity is conducted at passenger stations because large amounts of air freight are carried on passenger planes. The economics of the air freight business will preclude the high cost of handling freight in this manner and all air freight will be handled in "flying boxcars". Only mail, parcel post and express will be carried on passenger planes; however, even these will be carried in bulk on Cargoliners.

The air freight terminal of the future will center around a large warehouse with covered docking facilities for aircraft on the field side and covered docks for motor vehicles opposite. The aircraft docks present interesting engineering possibilities for the maximum in mechanical handling of goods to speed up the operation and minimize man power necessary to perform the job. It is not possible to reduce rates to a point where real volume will develop unless these facilities are engineered to do the job with maximum efficiency and economy. The business has come so fast that it has caught the industry without the necessary facilities to handle the volume.

Under the circumstances, a commendable job is being done. The potential of this business is enormous, and, in the opinion of the writer, if properly planned for on our airports, can develop into the major revenue of the commercial airlines just as the history of railroad transportation records the progression of the freight business.

Now just a word about management. Most airports are municipally owned and operated. A few, such as New York, Seattle and Portland are authority operated. Still fewer commercial airports are operated by private enterprise. A fourth possibility exists which would permit terminal corporations, either operated by the airlines collectively or by a corporation set up to do this particular job, to manage and operate in behalf of the owners.

Wherever sound management following accepted business principles is established, who operates it is not important. The really important objective is to get good, efficient business-like management free from political influence and endowed with an enterprising spirit to promote new activities, new sources of revenue and to coordinate all of the services provided by the airport so that each may perform its job without undue interference from the others. Management should always consider paramount the interests of the public which is paying the bill and make it easy for it to use the airport without great inconvenience.

Major improvements, such as discussed here, take much time. Many interests must be brought together into agreement in the planning stages, and once an agreement is reached, a long period of construction is necessary. During this period, interruptions to normal business are unavoidable. The airports of the future are still on the drafting boards and we cannot expect adequacy for several years. The ground planners can gain much if they will take on the spirit of the aeronautical engineers who have brought the progress of aviation to its present high standard. We must bring the ground plant up to this standard and into better balance in the forward-march of the entire industry.

Contributors . . .

(Continued from page 4)

joined the Illinois Tech faculty in 1937. During the recent war, Dr. Larkin served as a special mediation representative of the national War Labor Board and as vice-chairman of the Sixth Regional War Labor Board.

George S. Speer has been director of the Institute for Psychological Services of Illinois Institute of Technology since September, 1945. He received his bachelor's degree at Central Y.M.C.A. College and his master's at the University of Chicago. He served as research assistant for Mooseheart Laboratory for Child Research in 1935, as psychologist for the Child Guidance Clinic from 1937 to 1940, and as professor of psychology, dean of students, and director of the Institute of Guidance at Central YMCA College from 1940 to 1945.

Trends in Industrial Research

(Continued from page 12)

tive research developments increases as the scientific frontiers are rolled back. In spite of increasing costs, industry is well aware of the benefits of research and, to an increasing extent, considers its research expenditures as a vital and necessary investment in future security.

Only a few examples of returns on research investment, as reported by industry, are needed to illustrate the recognition given to results of scientific research:

A major oil company reports a return of $15,400 to its stockholders for every $1000 invested in research over a 10-year period.

A pharmaceutical company, reviewing its records of research investment for the past 20 years, finds a return of 100% on research investment.

One-third to one-half of the products of one of the largest electrical manufacturers had their beginning in the research laboratory.

A large chemical company states that 30% of its sales are of products developed through research since 1936.

An industrial machinery corporation reports a tenfold sales increase since 1937 and credits 80% of the increase to new products.

Surveys have indicated than 50% of the total employment in the United States is based on products coming from the research laboratories—thus one research man has created employment for almost 200 persons.

Numerous corporations are building new research laboratories to extend present facilities or to replace obsolete facilities. It has been estimated that more than 200 new laboratories were constructed between 1940 and 1946. In the reference cited above to *Barron's Weekly*, Bleiberg points out that almost a dozen multi-million dollar projects have been built or are in the planning stage.

Firestone Tire and Rubber Company built and put into operation in 1945 a $2 million laboratory. Radio Corporation of America will double its existing laboratories at Princeton, N. J. General Electric Company has announced a $10 million project for electronics laboratories. General Motors Corporation is planning a research and technical center, estimated to cost more than $20 million and intended to bring together the product research and experimental facilities of the company. Standard Oil Company (Indiana) plans to construct a large and modern laboratory near Chicago.

H. K. Ferguson Company has designed and built three major research laboratories during the year: Allied Chemical and Dye Corporation at Morristown, N. J., to centralize that firm's research activities; Bristol Laboratories at Syracuse, N. Y., for the production of penicillin and the study of new anti-biotics; Parke-Davis and Company at Detroit, Mich., for the production of streptomycin and the study of new anti-biotics.

Scientists and researchers in the field of anti-biotics are sure that they have only touched the surface and that penicillin and streptomycin are merely spearheads in the fight against disease. Bristol points out, in its announcement of the new laboratory, a policy common to many progressive organizations: long-range planning and facilities to enable a firm to capitalize on discoveries made in the research department. Lack of facilities undoubtedly would be more costly in the long run than present high building costs in terms of a competitive position in their industry.

The Johns-Manville Corporation, on October 16, 1947, unveiled the first big laboratory and pilot plant and laid the cornerstone of the second unit of a new research center group. Located on a 93-acre tract (Please turn to page 32)

(Continued from page 30)

forty miles from New York City, this group will ultimately include five or six units providing 337,000 square feet of laboratory space. Modular design gives an assembly of standard work space units for maximum flexibility. This laboratory center is said to be the largest in the world devoted to building materials, insulations, and allied industrial products.

Merck and Company has considered research a most essential part of its activities. In 1933 the company completed its first building devoted exclusively to this function. Laboratories now occupy almost 100,000 square feet of space in five modern buildings. Work was started in 1946 on a large new addition to the laboratories, which probably will be occupied in 1948. Emphasizing a trend in new laboratory construction, the building will be extremely flexible, with the basic unit a small, complete laboratory that has all necessary services. All partitions, except exterior and corridor walls, will be easily movable panels permitting the grouping of a number of units to form a laboratory of almost any size and shape. The laboratory staff now numbers 510 persons, with a technical staff of 250. Research expenditures were $3,438,279 in 1945 and $3,216,845 in 1946, close to six per cent of the sales dollar.

Greatly increased research activity by trade associations and organizations also demonstrates the growth of industrial research by all companies, both large and small. More than 125 associations were conducting research for their member companies before the war, and that number has steadily increased.

A pending publication of the Department of Commerce[5] summarizes work done by trade associations in their laboratories and in those of consulting, independent, nonprofit and university organizations. Associations such as the American Institute of Laundering and the Structural Clay Products Institute are considering substantial increases in their re-

(Please turn to page 34)

[5] *Scientific and Technical Research Activities of Trade Association,* edited by Gustav E. Larson.

DU PONT *Digest*

For Students of Science and Engineering

Research simplifies print making with development of "Varigam" Paper

Chemists and physicists make important contributions

Photographic film that has been overexposed or overdeveloped usually means a "hard" or "contrasty" negative—too much silver is deposited on the highlights in comparison with that in the shadows. The opposite effect, a "soft" or "thin" negative, results from underexposure or underdevelopment. At one time photographers had to stock four or five grades of enlarging paper to correct for these conditions and get the right degree of contrast.

To eliminate this expensive, unwieldy situation, scientists developed "Varigam" variable contrast photographic paper. With "Varigam," the whole procedure of getting different degrees of contrast is reversed. Instead of using several grades of paper, the photographer uses only one. He gets variation in contrast by use of filters that control the wave lengths of light reaching the paper, thereby getting finer degrees of contrast than are otherwise possible.

The action of "Varigam" depends on the ability of certain dyes to extend the sensitivity of silver halide emulsions beyond the blue and blue-green regions. This effect was well known to scientists. But "Varigam" has an added feature —it gives high contrast in the blue portion of the spectrum and is also sensitive to light in the green region, *with low contrast.*

"Varigam" the work of many men

The first job was one for the physical chemists. Silver halide emulsions, normally sensitive to blue light, had to be made to give maximum contrast when exposed to light in this region.

It was known that certain dyes would extend the sensitivity of the emulsion over as far as the infra-red. But they were not practical for photographic paper, being affected by the red safety light used in the darkroom. Research by chemists showed that certain dyes such as 1:1′-diethylthiopseudocyanine iodide extended the light sensitivity only to the green region. And, most important, they produced low contrast when used in lower-than-normal concentrations. When such a dye was combined with high-contrast silver halide emulsion, the result was an emulsion that gave high-contrast prints when exposed to blue light, and low-contrast prints when exposed to green light.

Physicists Develop Filters

Physicists made this contrast control a reality by preparing sharp-cutting filters that allow the user to control his printing light selectively. These filters, which are attached to the lens of the enlarger, range from blue for high contrast to yellow, which cuts out the blue almost entirely and gives low contrast. In between are eight grades of filters with intermediate degrees of blue and yellow light transmission. All of the filters are made in such a way that neither light nor printing time needs to be varied as filters are changed, except the last two on the blue end. These require approximately twice the time of the others.

In "Varigam," made by Du Pont, chemical science has given the photographer new economy and convenience in printing, and a degree of contrast control more precise than is possible with any combination of commercial papers.

Questions College Men ask about working with Du Pont

What types of training are needed?

The majority of openings for college graduates at Du Pont are in technical work and are usually in chemical, physical, or biological research; chemical, mechanical, civil, electrical, or industrial engineering. Openings are available from time to time in other fields, including architecture, ceramics, metallurgy, mining, petroleum and textile engineering, geology, mathematics, accounting, law, economics, and journalism. Write for booklet, "The Du Pont Company and the College Graduate," 2521-C Nemours Building, Wilmington 98, Delaware.

DU PONT

REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

More facts about Du Pont — Listen to "Cavalcade of America," Mondays, 8 P.M., EST on NBC

Normal print (center) can be obtained from either a "soft" negative (left) or a "hard" negative (right), using "Varigam" variable contrast paper.

(Continued from page 32)

search programs. Well-established research activities, such as those maintained by the Lithographic Technical Foundation, recently have been revitalized and expanded. The Commerce Department report states that at least 35 trade associations now maintain or operate their own laboratories, and these laboratories employ 800 to 1000 personnel, exclusive of fruit grower and processing groups. Among the larger laboratories are:

National Board of Fire Underwriters, 171 persons; American Gas Association, 120 persons; National Canners Association, 44 persons; Portland Cement Association, 37 persons; American Meat Institute, 31 persons; American Institute of Laundering, 30 persons, and Tanners' Council Laboratories, 25 persons.

Many associations use government laboratories, such as the Bureau of Standards and the Forest Products Laboratory, university laboratories, or non-profit research institute laboratories.

Much of the research done by trade associations is for small companies, although association activity is by no means confined to the smaller industrial organizations. Small companies are becoming increasingly conscious of their dependence on research to maintain their competitive position within an industry and to meet the technical developments made by competitive industries which can, and frequently do, threaten an entire industry with obsolescence and decay.

The National Research Council in 1940 surveyed 50 small companies having assets ranging from $150,000 to $2,500,000. Twelve companies stated "if they should immediately cease all forms of organized fact-finding in which they are now engaged, they would be forced out of business within a year". Six stated they would be liquidated in three years and 17 would at once experience a serious loss of competitive position.

Contrary to the pattern established in England where trade association research is substantially subsidized by the government and where association research forms a major part of research activity by industry, the United States government has assisted association research to a very limited extent. Recently, however, there has been a decided tendency on the part of government to assume a much greater role in financing and organizing association research. This tendency, supported in some quarters, has been vigorously opposed by a part of industry for reasons of patent policies, paternalism, alleged inefficiency of government supervision, etc.

Scientific and industrial research by industry, both large and small companies, is definitely on the ascendency. It is rapidly being recognized generally as a necessary part of business operation, and it is assuming an ever expanding position as a part of the corporate structure.

Research In Colleges And Universities

Today, as has always been the case, the basic source of progress in fundamental science resides in the laboratories of colleges and universities. Pushing back the barriers that cloak and obscure the trails of scientific advancement is, and should be, the main consideration of research in the university graduate schools.

To a considerable extent, our sources of basic scientific knowledge were in Europe prior to the last war, although several colleges and universities in this country had made notable contributions. The drying-up of foreign sources of fundamental scientific work, the drain on the stockpiles of scientific knowledge accelerated by wartime applied research, and the increased pressure for pushing back the frontiers of knowledge to provide basic information for postwar developments—all have greatly increased the demand for fundamental scientfic activity in university laboratories.

The increased demand for scientific research by the universities has come at a time when increased student enrollments have taxed the teaching staffs to such an extent that little time is left for research investigations. Funds from endowments are less plentiful because of lowering interest rates. And it is exceedingly difficult to attract and maintain an adequate staff because of the shortage of qualified scientists and the higher salaries offered by industry.

Universities have been quick to recognize the need for further basic scientific research and to meet the challenge of difficult postwar conditions. Most educators and research men feel, however, that financial assistance from industry and government is urgently needed if their obligations can be met. They emphasize that financial assistance must be given without restraints as to publication and patent protection or supervision if research in fundamental science is to be effective.

Industry is recognizing to a greater extent its obligation to finance scientific training and basic research, as evidenced by the increased number of industrially-sponsored fellowships and grants. Research fellowships and scholarships supported by industry now total 1800, compared with a total of 90 during 1929. The number of firms supporting such grants has grown from 56 to 302, and a number of other companies report their intention to provide such support and assistance as soon as facilities and personnel are available.

The federal government also recognizes its responsibility to give addional assistance to the universities. Although the legislation for a National Science Foundation, as passed by a large majority of the 80th Congress, was vetoed by the President, Congress seems to be united in feeling that financial assistance must be given for scientific training and research. It appears probable that assistance in some form will receive the early attention of Congress.

Several governmental agencies have placed research contracts with colleges and universities. The majority of such contracts have not contributed greatly to the furtherance of

(Please turn to page 36)

GRINNELL PROTECTION COULD HAVE PREVENTED THIS

YOUR PLANT IS BURNED and you must justify yourself before your Board of Directors . . . it is your word against the facts.

Will this be your defense?

YOU: *"Gentlemen, I wish to assure you I did everything I knew to protect our property and investment. I could not forsee a situation like this...it looks like carelessness with a cigarette."*

THE FACTS: It is a well-known and established fact that everyone who is human is careless at times. Anticipating carelessness is part of management's responsibility.

YOU: *"Our buildings were all of fireproof construction . . ."*

THE FACTS: But stored materials are seldom fireproof. All too often a fireproof building may merely serve as a stove for blazing contents.

YOU: *"I saw to it that we were covered by insurance. Of course it is not adequate for rebuilding at today's prices. We'll need capital — a lot of capital — IF we rebuild."*

THE FACTS: That property cannot be replaced for its insurance value today is but one of five sad aftermaths of fire. The other four, as managers of fire-gutted plants will attest, are: (2) An indemnity check never buys back a lost customer. (3) Burned-out records are lost forever. (4) Employees wander away. (5) Two out of five burned-out businesses never resume operation.

There is no sure way to prevent fire. But there *is* one sure way to stop fire immediately, automatically, wherever and whenever it strikes . . . Grinnell Protection by automatic sprinklers. Any competent fire chief will tell you that it is the surest way. On top of that, it usually pays for itself in reduced insurance premiums in a few years. So, if you're insured, you're paying for Grinnell Protection . . . . *Why not have it?* Grinnell Company, Inc. Providence 1, R. I. Branch Offices in Principal Cities

GRINNELL
FOUNDED 1850

Automatic Sprinkler and Special Hazard Fire Protection Systems

ENGINEERING GRADUATES HAVE FOUND ATTRACTIVE OPPORTUNITIES WITH GRINNELL

(Continued from page 34)
basic research, but have been directed toward the application of existing scientific knowledge. An outstanding exception has been the Office of Naval Research, which has maintained a broad program of basic research in the physical sciences and in medicine. Approximately 80% of this program is conducted by the colleges and universities, and about $50 million will have been obligated by the end of this year.

The universities have gone from a wartime total of about $20 million annually to a present rate of annual research expenditure of about $80 million. Some 300 or more universities are now engaged in either basic or applied research. More than 75 members of the Engineering College Research Council offer to accept projects from industrial sponsors.

The Council's 1947 directory lists facilities, major fields of investigation, and volume of sponsored research of the leading engineering educational institutions.

Several colleges, universities, and technological institutes have established research foundations or institutes. Some of these organizations are integral parts of the educational institution; some are closely affiliated with it, but exist as separate corporations; and others are independent, non-profit corporations with a more-or-less close affiliation. Contractual relations, patent policies, publication policies, and charges for industrially sponsored projects vary widely between organizations. It is evident that economic pressure has been a dominant factor in causing many universities to seek applied research projects supported by industry.

Many individual scientists, research leaders, and educators have pointed out that investigations in the field of applied research do not often contribute substantially to the primary university functions of scientific education, graduate study, and basic research. When industry supports basic research, the effect upon the university is a salutory one, according to David Gordon of David Gordon and Company. Dr. Jacques Errera, speaking at a recent meeting of consulting chemists and engineers, cautioned that the role of the university is two-fold: *First,* it must educate; it must supply the bachelors, masters, and doctors who will carry on the nation's research and development program; this activity must be self-supporting on a high level; for this support, it must look to both private and public funds. *Second:* he continues, the research function must involve basic research.

Certainly there is a trend toward increased scientific activity in the universities and colleges: increased college enrollments at all levels in scientific education; additional emphasis on graduate research and basic scientific research; and increased desire on the part of the colleges to seek industrially sponsored research, a part of which will contribute to the primary functions of scientific education and research.

(Next month, the author will review the trends in public service research organizations, government in research, research in the international field, management of research, and research in management.)

Successful telecasts of surgical operations show value of television to medical education.

"*Step up beside the surgeon—and watch*"

Not long ago, a radio beam flashed across the New York sky—and "carried" more than 7000 surgeons into a small operating room . . .

Impossible? It was done by television, when RCA demonstrated—to a congress of surgeons—how effective this medium can be in teaching surgery.

In a New York hospital, above an operating table, a supersensitive RCA Image Orthicon television camera televised a series of operations. Lighting was normal. Images were transmitted on a narrow, line-of-sight beam . . . As the pictures were seen the operating surgeons were heard explaining their techniques . . .

Said a prominent surgeon: "Television as a way of teaching surgery surpasses anything we have ever had . . . I never imagined it could be so effective until I actually saw it . . . "

Use of television in many fields—and surgical education is only one—grows naturally from advanced scientific thinking at RCA Laboratories. Progressive research is part of every instrument bearing the names RCA or RCA Victor.

When in Radio City, New York, be sure to see the radio and electronic wonders on display at RCA Exhibition Hall, 36 West 49th Street. Free admission to all. *Radio Corporation of America, RCA Building, New York 20, N. Y.*

Continue your education with pay—at RCA

Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short wave and FM circuits, television, and phonograph combinations).
- Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.
- Design of component parts such as coils, loudspeakers, capacitors.
- Development and design of new recording and reproducing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

Write today to National Recruiting Division, RCA Victor, Camden, New Jersey.

Also many opportunities for Mechanical and Chemical Engineers and Physicists.

RCA

RADIO CORPORATION of AMERICA

. . . Research in Geometry

(Continued from page 14)

chophysics (e.g., to the geometry of our skin sensations derived from experiments on thresholds of sensation). Moreover, general geometries of the small might find applications to molecular physics as general geometries of the large were applied to cosmology.

II. Finite Planes And Agriculture

Another study that started as a highly theoretical activity is the construction of finite models for complicated mathematical systems. Such a model for arithmetic is known to everybody: the arithmetic of the clock. This miniature arithmetic has only twelve objects which every school child adds together and subtracts from each other in a perfectly consistent way. For instance, in this arithmetic $11 + 4 = 3$ because 4 hours after 11 o'clock it is 3 o'clock. Even multiplication can be defined for the 12 numbers of the clock arithmetic although in practical life we have no occasion to go beyond addition and subtraction.

In clarifying the foundations of geometry at the turn of the century, Fano and Veblen introduced miniature planes, namely: finite systems of points and lines which may be considered as models of plane geometry in the same sense as the 12 numbers on the clock form a model of arithmetic. With regard to plane affine geometry, that is, that part of plane euclidean geometry which is independent of the concepts of perpendicularity and congruency, the question arose as to whether one could find finite systems of points and lines satisfying the following postulates:

1. Through two distinct points there is exactly one line.
2. To a given line *1*, through a given point *P* (not on *1*) there is exactly one line that has no common point with *1* (Euclid's parallel postulate).
3. On each line there exists at least one point. (From the other postulates it readily follows that on each line there exist at least two points.)
4. There exist three points that are not on a line.

The answer to this question is affirmative. The simplest example consists of four points,

$$P, Q, R, S,$$

and six lines each containing two points, namely:

$$(PQ),\ (PR),\ (PS),$$
$$(QR),\ (QS),\ (RS).$$

It is not possible to find examples with more than 4 and less than 9 points but there is an example of a finite plane containing 9 points and 12 lines. One way of describing this

(Please turn to page 40)

(Continued from page 38)

example is the following "Greco-Latin square"

$A\alpha$	$B\beta$	$C\gamma$
$C\beta$	$A\gamma$	$B\alpha$
$B\gamma$	$C\alpha$	$A\beta$

where each of the nine pairs of letters represents a point, having the Latin letter as abscissa and the Greek letter as ordinate[3]. There are three "vertical" lines each joining three points in a column of the above scheme, and three "horizontal" lines each joining the three points of a row of the above scheme. Besides there is an A-line consisting of the three points, $A\alpha$, $A\gamma$, $A\beta$ with the abscissa A. Similarly there are a B-line and a C-line. Finally there is an α-line consisting the three points $A\alpha$, $C\alpha$, $B\alpha$ with the ordinate α. Similarly there are a β-line and a γ-line. One could easily verify that this system of nine points and twelve lines satisfies the postulates 1, 2, 3, and 4 mentioned above and thus constitutes an affine plane. As an example, we determine the line through the point $B\gamma$ which is parallel to the line joining the points $B\beta$ and $A\beta$. The latter line is the β-line containing $C\beta$, $B\beta$, $A\beta$. As one readily verifies, there is exactly one line containing the points $B\gamma$ and not intersecting β-line, namely, the γ-line containing $B\gamma$, $A\gamma$, $C\gamma$.

The next larger model consists of 16 points and 20 lines; then comes a model with 25 points and 31 lines.

Two thoughts are bound to occur to the practical man: "Obviously, for every number n, there exists an affine plane containing n^2 points. But what a useless endeavor to set them up, enumerate them, and classify them."

First of all, the matter is considerably less simple than it appears to be at first glance. For instance, it is not true that for every n there exists an affine plane containing n^2 points. There are such planes provided that n is a power of a prime number such as $2, 3, 4 = 2^2, 5, 7, 8 = 2^3, 9, = 3^2$, 11, etc. But it follows from a note by F. H. Safford in the American Mathematical Monthly in 1907, that there does not exist an affine plane for $n = 6$, that is, an affine plane with 36 points.

Secondly, while for almost half a century these finite planes were indeed merely of intellectual interest, modern statistics has changed the situation. Finite affine planes have found extensive use in the design of experiments, especially agricultural experiments. For instance, if we wish to try out three kinds of fertilizers A, B, C and three kinds of seeds α, β, γ, the best procedure is to divide the rectangular field on which we experiment into 9 equal rectangular parts and try on each ninth a combination of one fertilizer and one kind of seed according to the "Greco-Latin Square" which we mentioned as a finite model for an affine plane.

One advantage of the above Greco-Roman arrangement as compared, say, to the arrangement

Aα	Bβ	Cγ
Aβ	Bγ	Cα
Aγ	Bα	Cβ

is obvious. If the soil on the field on which we experiment should get more fertile as we move to the right, then in the latter arrangement an inferior fertilizer C might produce better results. In the Greco-Roman Square each fertilizer is applied once in each row and once in each column whereby the effects of vertical and horizontal fertility gradients of the soil are eliminated.

But there are several other applications of the Greco-Roman Square, in particular, if we wish to test combinations of four different types of treatments, each type represented by three variants. In fact, it was statisticians who introduced the Greco-Roman symbols for the finite affine planes. In 1932, Fisher and Yates rediscovered the impossibility of an affine plane with six points on each line. In India, one of the main centers of modern statistics, a recent publication was devoted to finite geometries.

In concluding, we remark that

(Please turn to page 42)

[3] The terms abscissa and ordinate here are not coincidental. Each finite model of an affine plane can be introduced as an analytic geometry in which the coordinates range over a miniature arithmetic (related to that of the clock) instead of ranging over the totality of all real number as they do in the analytic geometry of our normal euclidean plane.

HOW TO GET A PATENT

To be patentable, a technical contribution must be both new and useful. At Standard Oil (Indiana) there exists a stimulating atmosphere in which our technical men continuously contribute to progress with new, useful inventions.

The work of all our research men is reviewed by trained patent advisors. When a researcher conceives a new solution to a problem, he is encouraged to submit it in the form of a disclosure. A careful search is made on his behalf by Standard Oil library research experts and patent attorneys. Their findings and the results of laboratory tests go with the disclosure to an application committee. On the average, one patent application is filed for every seven disclosures submitted.

This procedure gets results for Standard Oil and Standard men. We believe it compares most favorably with the patent practices of other industries—and few indeed can match Standard's record for technological progress.

Standard Oil Company

(INDIANA)

910 S. Michigan Avenue, Chicago, Illinois

STANDARD

STANDARD SERVICE

(Continued from page 40)

statisticians have also made use of finite models for geometries which differ from Euclid's, in particular for projective geometry. A projective plane can be obtained by adjoining to an affine plane one line ("line of infinity") and its points ("points of infinity"). In a projective plane every two lines intersect and thus no parallel lines exist. While there exist finite projective planes (in fact, the first finite models of Fano and Veblen were for projective planes) it has been recently proved by collaborators of the writer that there are no finite Bolyai-Lobachevsky planes except planes in which each line contains only two points. For the visible space there are no finite models whatever[4]. On the other hand, we may mention finite models for analysis which we recently constructed; that is, finite systems of entities behaving like functions in that they can not only be added and multiplied but also substituted into each other according to the laws of what we call "Algebra of Analysis."

III. Networks And Topology

An example of applied mathematics which later gained considerable theoretical significance is the theory of electrical networks developed by Kirchhoff in 1847. The question of interest to the physicist was this: Suppose that a finite number, α_1, of branches are somehow connected in α_0 nodes so as to form a network. Each branch contains a known resistance and a known source of e.m.f. What will be the currents in the α_1 branches?

Kirchhoff's two famous laws about currents supplied him with linear equations for the α_1 unknown currents of the network, one equation corresponding with each of the α_0 nodes, and one equation corresponding with each circuit of the network. Kirchhoff readily proved that while the α_0 node-equations were dependent, any $\alpha_0 - 1$ of them were independent. Much more complicated is the problem of setting up the maximum number of independent circuit-equations.

Kirchhoff arrived at a solution by a penetrating geometrical analysis of the network. Clearly the shapes and lengths of the branches are irrelevant for the problem, once the resistances of the branches are given. What matters are merely the relations between the branches and nodes, more precisely, whether or not the *n-th* branch begins or terminates at the *m*-th node. Here, *m* ranges from 1 to α_0, and *n* from 1 to α_1, and "beginning" and "terminating" is meant in the direction of the e.m.f. on the branch[5]. Kirchhoff found that in each network he could choose $\alpha_1 - \alpha_0 + 1$ branches after whose deletion the network became acyclic (i.e., free of circuits) while all nodes were retained. With each of these deleted branches he could connect branches of the acyclic "skeleton" so as to obtain a circuit of the original network.

The $\alpha_1 - \alpha_0 + 1$ linear equations corresponding with the circuits obtained in this way are readily seen to be independent. Combining these $\alpha_1 - \alpha_0 + 1$ independent circuit-equations with the $\alpha_0 - 1$ independent node-equations Kirchhoff obtained a system of α_1 linear equations for the α_1 unknown currents and thought that he thus could always compute the currents by solving the equations. This reasoning was inadequate since the two independent systems of equations need not and, in fact, do not always combine to an independent system of equations[6]. But fortunately, as Weyl proved in 1924, the combined system of α_1 equations will be independent provided that all the α_1 resistances are positive. Negative resistances were discovered long after Kirchhoff.

The simplest example of a network for which, in presence of negative resistances, Kirchhoff's equations needs not yield a unique solution, is obtained by joining two nodes N_1 and N_2 by two branches B_1 and B_2 (Fig. 3). We call r_1 and r_2 the resistances, E_1 and E_2 the e.m.f. in B_1 and B_2, respectively, and assume that the direction of both forces is toward N_1. We denote the unknown currents by i_1 and i_2. Then the $\alpha_0 = 2$ node-equations read

$$i_1 + i_2 = 0 \text{ and } -i_1 - i_2 = 0.$$

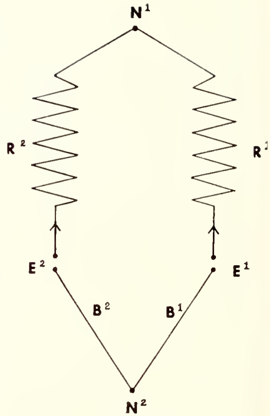


Figure 3.

They are dependent but either one of them is independent (i.e., not identically satisfied). There are two circuits, which are identical except for the orientation which is clockwise in one, and counter-clockwise in the other. We obtain $\alpha_1 - \alpha_0 + 1 = 1$ independent circuit equation

$$r_1 i_1 - r_2 i_2 = E_1 - E_2.$$

A system of $\alpha_1 = 2$ equations for i_1 and i_2 reads

$$i_1 + i_2 = 0,$$
$$r_1 i_1 - r_2 i_2 = E_1 - E_2.$$

This system is independent if and only if $r_1 \neq -r_2$. If $r_1 = -r_2$; that is, if the resistances are equal in magnitude but one is positive and one negative, then the two equations are dependent. In this case, they read

$$i_1 + i_2 = 0,$$
$$i_1 + i_2 = E_1 - E_2$$

and obviously have no solution if

[4] Proved by R. A. Kliphardt, a graduate student at Illinois Institute of Technology.

[5] A branch without a source of e.m.f. may be said to begin at either point and to terminate at the other one.

[6] An excellent discussion of these questions is to be found in D. Koenig "Theoric der endlichen und unendlichen Graphen" (1936).

$E_1 \neq E_2$, while i_1 may be any number if $E_1 = E_2$.

In a less conspicuous way, the same situation prevails in some more complicated networks containing negative resistances.

Apart from its practical application, Kirchhoff's study has had numerous theoretical consequences. The number $\alpha_1 - \alpha_0 + 1$, later called the "cyclomatic number" of a one-dimensional connected graph with α_0 nodes and α_1 branches, has become the corner stone of the combinatoric topology of graphs. Combinatoric topology is that branch of geometry which deals only with those profound properties of spatial objects (made of a finite number of simple parts) that depend merely upon incidence relations between the parts and are independent of such quantitative features as length, area, volume, etc.

The scope of this theory goes far beyond one-dimensional graphs which, like networks, consist of branches connecting nodes—although the branches need not be wires, in fact, not even geometrical lines but may be sublimated to mere indicators of relations. The number $\alpha_1 - \alpha_0 + 1$ has found extremely important generalizations to higher-dimensional objects of combinatoric topology which contain also triangular surfaces, tetrahedral solids, etc.

IV. Geometric Thinking And Human Organization

We study a group, G, of human beings which is divided into two mutually exclusive subgroups, G_1 and G_2, such as men and women, selfish and unselfish persons, English and French speaking people, or the like.

Let us further assume that everybody has a subjective attitude toward these groups. Some members of G wish to associate only with members of G_1. We call the class of these persons the attitude group A^1. (For the sake of simplicity we limit ourselves to the study of the special case that the attitudes are universal in the sense that a person who likes association with *one* member of G_1 likes association with *any* member of G_1.) Similarly, there is an attitude group A^2 of persons who wish to associate only with members of G_2. Finally, there is a group A^{12} of "tolerant" persons who associate with everybody, and a group A^0 of "hermits" who associate with nobody.

The group G_1 is divided into four subgroups,

$$G^1_1,\ G^2_1,\ G^{12}_1,\ G^0_1.$$

consisting of members who belong to the attitude groups A^1, A^2, A^{12}, A^0, respectively. Similarly, the group G_2 is divided into four subgroups,

$$G^1_2,\ G^2_2,\ G^{12}_2,\ G^0_2.$$

We shall refer to these eight groups as the *basic* groups.

A subgroup of G is said to be *coherent* if each two members of the subgroup are willing to associate with each other. Clearly, the basic group G^1_1 is coherent in this sense. For every member of G^1_1 belongs to

(Please turn to page 44)

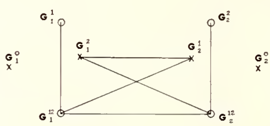
(Continued from page 43)

G^1 as well as to the attitude group A^1 of people associating only with members of G_1. Since also all the other members of G^1_1 belong to G_1 every member of G^1_1 will be willing to associate with every other member of G^1_1. Similarly, G^2_2, G^{12}_1 and G^{12}_2 are coherent groups. On the other hand, none of the groups G^2_1, G^1_2, G^0_1, G^0_2 is coherent. In fact, these groups are explosive in the sense that no two members of the same group wish to associate with each other.

Moreover, we see that each member of G^1_1 and each member of G^{12}_1 are willing to associate with each other. Two groups in this relation will be called *compatible*. One readily sees that among the eight basic groups there are altogether six compatible pairs, namely,

G^1_1 and G^{12}_1; G^2_2 and G^{12}_2; G^{12}_1 and G^{12}_2;
G^2_1 and G^{12}_2; G^1_2 and G^{12}_1; G^2_1 and G^1_2.

If we indicate each coherent group by a circle, each explosive group by a cross, and join two such "nodes" by a "branch" if and only if the two groups are compatible, then the network of the simple human relations that we are studying is represented by the following graph:



How can we divide G into coherent subgroups? Obviously, there are only the following types of coherent groups:

(A_1): groups consisting of members of G^1_1 and of members of G^{12}_1, special cases being groups containing only members of G^1_1 or only members of G^{12}_1;

(A_2): groups consisting of members of G^2_2 and G^{12}_2;

(B): groups consisting of members of G^{12}_1 and G^{12}_2;

(C_1): groups consisting of exactly one member of G^2_1 and any number of members of G^{12}_2, special cases being groups consisting of one member of G^2_1 only;

(C_2): groups consisting of exactly one member of G^1_2 and any number of members of G^{12}_1;

(D): groups consisting of exactly one member of G^2_1 and one member of G^1_2;

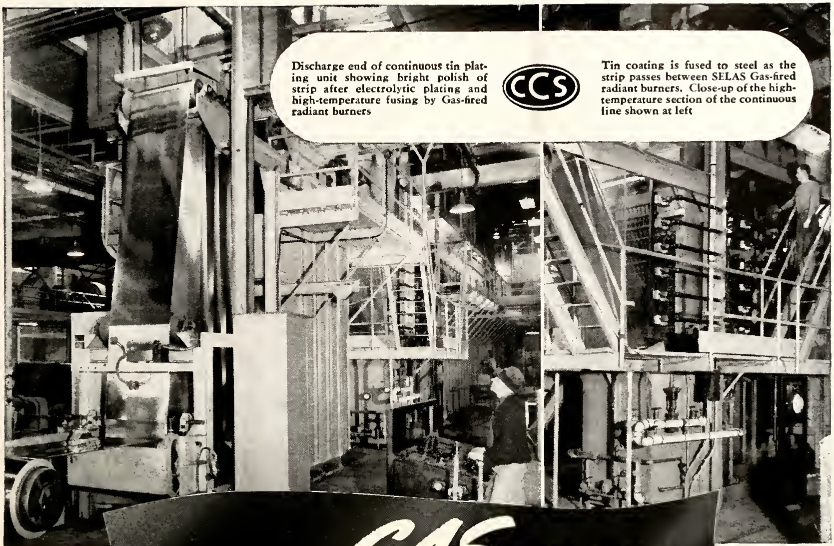
(E_1) and (E_2): groups consisting of one single member of G^0_1 or G^0_2, respectively.

In particular situations, some of the eight basic groups are vacuous or at least insignificant. For instance, if G_1 and G_2 denote persons speaking different languages, only the coherent basic groups G^1_1, G^2_2, G^{12}_1, G^{12}_2 are significant, and groups of the types (A_1), (A_2), and (B) are the only coherent groups that are likely to materialize.

On the contrary, if G_1 and G_2 are men and women in a party, then with regard to the attitude toward dancing only the explosive basic groups are significant: men who wish to dance with women; women who wish to dance with men; and non-dancers. Accordingly the only sets that will materialize are dancing pairs of the type (D), non-dancers of the type (E), and wallflowers forming special groups (C).

If G_1 are despots, G_2 the other people, the only groups that are likely

(Please turn to page 46)



Discharge end of continuous tin plating unit showing bright polish of strip after electrolytic plating and high-temperature fusing by Gas-fired radiant burners

CCS

Tin coating is fused to steel as the strip passes between SELAS Gas-fired radiant burners. Close-up of the high-temperature section of the continuous line shown at left

RADIANT *GAS* BURNERS *create high-temperature* tin-coat fusing zone

BRIGHT FINISHING was the problem—and engineers of Crown Cork and Seal Company, Inc., Baltimore, adopted a high-temperature method for fusing tin to low-carbon strip, with resultant high-polish surface, in a continuous production mill.

Then, to obtain the high temperatures necessary for heat-processing, these engineers selected GAS and modern Gas Equipment. By directing the heat of radiant GAS burners over a concentrated area of the freshly-plated strip it was readily possible to coordinate the fusing action with the plating process to accomplish continuous high-speed production of bright finished strip.

This typical installation demonstrates the flexibility of GAS and the applicability of modern Gas Equipment for continuous, production-line heat processing. Compared with available fuels GAS is most readily controlled by simple automatic devices; Gas Equipment can be adapted for use with existing machinery or incorporated in new machinery without radical design changes, or expensive supplemental apparatus.

Manufacturers of Gas Equipment and the American Gas Association support continuing programs of research designed to assure the most efficient use of GAS for every heat-processing requirement.

AMERICAN GAS ASSOCIATION
420 LEXINGTON AVENUE, NEW YORK 17, N. Y.

MORE AND MORE...

THE TREND IS TO GAS

FOR ALL
INDUSTRIAL HEATING

(Continued from page 44)

to materialize are: groups of type (C_1) consisting of one despot of the group G^2_1 and passive persons of the group G^{12}_2; and groups of the type (A_2) consisting of persons of G^2_2 and G^{12}_2.

In concluding we discuss the formal (extensive) aspect[7] of the categorical imperative: to behave toward others as one wishes everybody to behave. We see that the members of G^1_1, as well as the members of G^2_2 fulfill this condition. Yet the union of the two groups is not coherent. On the other hand, a member of the group G^2_1 does not fulfill the condition of the categorical imperative and may nevertheless be included in coherent sets: in a pair consisting of him and a member of G^1_2; or in a set containing besides him only members of G^{12}_2. Abidance by the categorical imperative is thus neither necessary nor sufficient for the coherence of a group.

What are possible applications of such theories of human groups and relations? Because theories of this kind are necessarily and admittedly formal they are looked upon with misgivings if not contempt by those who search for "absolute aims". Now, whatever one may think of the chances of this latter search, or the very meaning of its objective—one must admit that no agreement as to the goal has been reached. Equally, even if one thinks that formal reasoning can, and ought to be, supplemented by material studies, one must admit that its modest results are valid. Shall we let the bird in the hand go for the sake of the two in the bush?

Stability of organizations and happiness of individuals are essentially based on something related to the coherence of groups which we have studied in a simple case. One of the aims of formal theories of human relations is the discovery of schemes for the division of groups into coherent subgroups. It is well known that the systematic synthesis of pharmaceutical products results in dozens, if not hundreds, of compounds which are discarded while occasionally one is found which marks a progress. In the same way, a systematic formal study of relations between human individuals and groups would undoubtedly lead to many impracticable schemes. But then occasionally it might bring to light possibilities which are overlooked in a passionate material approach.

The general trend seems to be toward the formation of uniform groups. This is indeed the easiest solution of the problem. But, as we saw in discussing the categorical imperative, uniformity is neither necessary nor sufficient for coherence. In many situations, with some thought, we may find divisions into subgroups that impose considerably smaller constraint on individuals and thus promote human happiness and progress.

[7] For a critique of the material content (or rather, the lack of material content) of this principle, *cf.* the author's paper in *Amer. J. of Sociology* 43, (1938) p. 790.

BUSINESS IN MOTION

To our Colleagues in American Business . . .

Are you using your supplier's brains, as well as his materials? It will pay you to do so. Let us give you three examples that will show you what we mean. First, there was the Revere customer who was found to have in his shop a hand-soldering operation costing about 2¢ per unit. We suggested a spot-welding machine which cut the cost to a fraction, and did a better job.

In another case, spot welding was impractical because of the nature of the materials, and soldering was inevitable. Here Revere recommended portable induction soldering equipment. This proved to be so effective in lowering costs that we have since brought it to the attention of other customers using hand-soldering methods.

The question of rod versus strip is another subject of great interest in these days of endless search for better and faster methods. In our experience, quite often a part can be made from strip just as well as from rod, and at much lower cost. For instance, one of the Revere customers was making a knob escutcheon and bushing in a screw machine, turning out 150,000 pieces per month. He was using large quantities of bronze rod. It was pointed out to him that the part could be produced just as well by an eyelet machine using bronze strip, substantially reducing every cost element, and resulting in a product of equal appearance and serviceability.

These are but three of many instances of special service given by Revere. You will note that the essential factor and common element in each case was the willingness of the customer to provide complete information about methods and end uses. Only this made it possible for us to collaborate with our friends in the successful search for cost-reducing materials or processes.

Revere is by no means the only company accustomed to work in this way with its customers and prospects. Every important supplier in the country is fully informed about his materials, whether they be solids or fluids, organic or inorganic. We suggest that no matter what you make, or how, it will pay you to give your suppliers the privilege of collaboration.

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

☆ ☆ ☆

Executive Offices:

230 Park Avenue, New York 17, N. Y.

Profession: *Homemaker*

(Continued from page 16)
standards, appearance, and social usage are stressed throughout. The nutritive value of foods is studied in relation to the nutritive needs of various age, sex, and activity groups. Emphasis is placed upon menu planning, marketing, and preservation of nutritive value by proper handling.

Dietary practices of sub-cultural groups are studied and related to the economic, social, and psychological factors that impinge upon an individual, influencing his choice of food, and ultimately his nutritional status. Students learn to improve their own dietary practices, to like new foods, and to overcome food prejudices by studying the relation of nutrition to positive health and methods of changing food habits to improve nutritional status.

Household equipment is studied from the standpoint of construction, use, selection, and care. The student has access to many types of modern equipment and has opportunity to learn through use tests the essential and the desirable features, and the features to be avoided. Kitchen planning and work units designed for efficiency and economy of time and effort are given special consideration.

In the textiles and clothing, the course follows a systematic study of fabrics used for clothing and household textiles. One learns to identify natural and synthetic fibers and to understand differences of yarn construction. Various types of weaves commonly used in home fabrics and finishing processes that impart special characteristics are studied. Knowing the relative importance of fiber, yarn construction, weave, and finish to the appearance, durability, cost, and use of fabrics, one can make intelligent selections from the wide variety displayed to the consumer. The study of clothing includes the selection, construction, and care of clothing best suited to the needs of the individual. The course also includes pattern alteration and design, and tailoring processes.

The study of aesthetic values in family life is known as related art. Each person becomes acquainted with basic principles of design, line, form, and color and learns to know and appreciate artistic values. Through the study of costume design, artistic principles are applied to the problem of line, color, and style to the end that clothing best suited to the individual may be selected. Interior design teaches the effective use of color, line, and texture in interior decoration. It stresses period furniture, arrangement, and functional design. House planning considers requirements for modern living and the best use of space, placement of the home on the lot, and other problems of exteriors. After a study of related art, the student is prepared to plan or choose her surroundings with good taste and without sacrifice of efficiency. She is aware that a home should provide a place in which its family members can live, perform their work, and pursue their avocations, and that this is best done in surroundings where artistic qualities satisfy aesthetic needs.

The study of child development and care, required of all students, covers the physical, mental, and social development of children from the pre-natal through the pre-school period. Special emphasis is placed on nutrition and its importance to all aspects of the child's development. The objective of study in this field is to produce a home environment best suited to the needs of the child so that he may grow to full realization of the potentialities with which he is endowed.

Help For The Consumer

In our modern society, family economics is largely a problem of consumption. Production is still practiced in the home in varying degrees, but in urban areas the needs of the family are supplied primarily through the purchase of goods and services produced outside the home. Studies in this field have demonstrated repeatedly that the standard of living obtained by any family depends fully as much on the use of income as it does on its size. Nutrition studies show that adequate diets are not insured by large expenditures for food. There is no expenditure level at which all families obtain adequate diets, whereas, at a given expenditure level above the mini-

mum, good, fair, or poor diets are obtained by different families.

Home economics has always concerned itself with the problems of the consumer. Use tests, standards of adequacy, informative labeling, specifications, are all terms familiar to the home economist; they are common tools of her trade. She believes that the consumer is entitled to know what she is buying and what she can expect from her purchases in terms of performance, durability, cost of upkeep, and satisfaction. The experiences of the general public in the past few years, coupled with the pressure of inflation against all family incomes, have persuaded many persons to take more care in their purchases. The Consumer Speaks project of the American Home Economics Association has demonstrated that consumers are interested in performance as well as price. It has contributed and is still contributing valuable information on the consumers wants and needs and her experiences with present consumer goods. This information is also invaluable to maufacturers and distributors whose primary interest is service to the consumer.

Best use of family income is emphasized through a study of budgeting based on the detailed study of quantity, quality, and cost in each specialized consumption area. Time management, as well as money management, is important if maximum satisfaction is to be experienced from resources available to a family. Since this is true, the study of home economics includes an evaluation of labor-saving devices in terms of time as well as cost of operation and investment.

Careers For Home Economists

After completion of the curriculum, a student has a background of theory and practice in the problems facing the modern homemaker. Many opportunities for an interesting and varied career await the graduate. She may be a teacher, a dietician, a nutritionist, or a home economist in a welfare agency or business firm. At present there is a shortage in all professional fields that require home economics training. Financial returns from all are good. Opportunities for advancement are available for those who have the personal endowments required for success in the chosen field, in addition to the basic knowledge acquired through training. The speed and degree of advancement are limited only by the qualifications and industry of the individual.

Teaching is probably the best known field for the graduate home economist. Many elementary and secondary schools offer courses in homemaking. The rewards of teaching are great because of the close contact with pupils and because, in general, the pupils are quite interested in the subject. For teaching in colleges, further study and specialization at the graduate level is essential. Research is often combined with teaching in colleges and universities, as is the case in other subject-matter areas.

Dietetics and institutional food service present attractive occupational possibilities. The duties of an administrative dietitian or food service manager include complete responsibility for menu planning, food purchase, preparation and service, and personnel management. The therapeutic dietitian is concerned with the use of food for treatment in various types of illness. She works with doctors to devise diets, plan menus, and interpret to patients the dietary regime best suited to each one's needs. Many times her work also includes research. To qualify as a dietitian, a dietary internship in a hospital is required after graduation from college. For commercial food service directors, apprenticeships are available in many hotels and restaurants. In addition to the required *(Please turn to page 50)*

(Continued from page 49)

curriculum, the prospective dietitian attending Illinois Institute of Technology must use electives for the study of large quantity cookery, institutional management, and diet in disease.

Business offers an ever increasing number and variety of positions to home economics graduates. Consumption of many goods and services centers in the home and the greatest responsibility for their choice rests with the homemaker. Since industry desires to meet the needs of the homemaker, it has found invaluable the advice of women who have completed a study of homemaking. These home economists contribute to equipment design and product development. Merchandising, advertising, and public relations also claim their services. Although the food industry has made the greatest use of home economist, there is also a demand for them in the equipment and textile fields. In all three industries there are openings in manufacturing and in wholesale and retail distribution.

Public health agencies employ home economics graduates to direct their nutrition education programs. Openings in this important field have multiplied in the last few years because physicians and health educators have come to appreciate the importance of nutrition to the public health. The appalling number of youths rejected by the Selective Service System because of defects that could have been prevented or remedied by proper diet dramatized the existence of a great gulf between what is known about nutrition and what is practiced. Except for minor gaps, we know what constitutes an adequate diet for all age, sex, and activity groups, yet dietary studies show that the food intake of a large proportion of the population is suboptimal. It is the nutritionist's task to bring about in practice the standard made possible by present day knowledge. To this end she teaches the public through classes, interviews, and the printed page.

Home economists employed by welfare agencies serve as consultants. They advise the agencies regarding kinds and amounts, as well as costs, of goods and services that will enable families to maintain health and participate in normal community life. Standard budgets, currently priced, are used by the agency to determine eligibilty for assistance as well as assistance grants. As a consultant to the case work staff, the home economist may also be called upon to assist families in the solution of management or nutrition problems. Home economics in social welfare is a growing field and has in recent years expanded to budget counseling for self-supporting families not seeking assistance, but wanting to better manage their incomes.

So far this discussion has been confined to a consideration of women with a major interest in home economics; however, students majoring in other subjects are also welcome in the classes. Although it is primarily a woman's field, there are certain aspects in which men are interested. Textiles, nutrition, and art are illustrative. Classes are open to men at Illinois Tech, and in some evening classes they outnumber the women students. A few have enrolled in the day school and it is hoped that this practice will become more common, for a better understanding of the problems of the home is important to all the family members, men as well as women.

The department is now located in the Loop, but included in the building program at Technology Center is space specifically designed for home economics laboratories. The new home will be in the Liberal Studies building. New facilities will make it possible to offer a more varied program, especially in advanced study for professional work. This is in keeping with the Lewis Institute tradition where home economics courses were offered from Lewis' founding in 1896; it also coincides with the policy of Illinois Institute of Technology, where students receive technical training for positions of leadership in business and industry.

The Challenge to Freedom

(Continued from page 17)

as Barbara Ward has so succinctly stated, "That they can be separable is a matter of theory, not of fact."

Part II

Let us come now to our second factor in the advancement of freedom. It is one which seems far removed from the realm of religion. Yet it is a force to be reckoned with in the Western World. Many will say that its influence upon twentieth century America is nowhere matched. And while it is not generally credited with a major role in support of man's freedom, I believe that such a role is not lacking in this connection. I refer to the growth of science and technology—and particularly to the influence which controlled inanimate power has had in shaping our destinies.

With the invention of the steam engine man began to enter into his present illimitable treasury of power. Less than two hundred years ago civilization was dependent upon man-power, largely in the form of slave or serf labor, augmented somewhat by the use of domestic animals, falling water, or the winds of heaven in sails and windmills. Man employed tools and skills to spin and weave. He used wheel carriages for transport. But the forces of nature were only employed where they could be found. They could not be stored or transported. Therefore, a vast amount of man's work had to be done by hand, and the chief source of his power was manpower or the use of animals.

It is little wonder that in a world of such nature, men of power and organizational ability imposed their will upon more docile men, thus creating a state of servitude. It is also an historical fact that slavery and various forms of serfdom prevailed in practically all societies which antedated this modern era in which science and technology has made available greater power and a wider distribution of the various forms of inanimate power. Therefore, we may attribute the growth of man's freedom, in part at least, to his mastery of those elements which have afforded him greater sources of available and transportable power. There is no longer occasion for enslaving and degrading our fellow man to use his muscular power, since cheaper and more efficient sources of power have been provided in abundance.

The many civilizations which have preceded ours have not been barren. Nor have they all been brutish. At favored times and places there have been materially rich civilizations. In art, in literature, in philosophy, in religion, in all that expresses beauty and the rich potentialities of the human mind and personality, and makes possible the highest form of human happiness, man achieved a quality which he has never surpassed since he has entered into his heritage of greater power.[2] But cultural advantages and leisure through these earlier centuries were the privilege of the favored few. And those who reaped the rewards of such earlier civilizations generally did so with a much greater degree of exploitation of their fellow men.

To illustrate this from our country's history—and from that of the British — England was one of the first countries to become industrialized. She was also one of the first to champion the cause of freedom, and without a great military struggle, was the first to free her slaves. In this country the industrialized North was the first to take the stand against slavery, and in the final struggle for abolition, the Union's victory over the South was assured by its greater industrial machine. Even the McCormack reaper, which released many able-bodied men from the farms to the army and made possible the harvesting of grain by the older men and the women, was a factor in bringing the war to a successful conclusion.

Today, power, mechanical appliances, the instantaneous transmission of news, and all of the technological advances that go with these, are the dominant forces in determining the material basis of man's life; the structure of his society and his government; the character of his opportunities and his problems. For the first time in history mankind now has sufficient material resources and skill to provide not only the necessities but also the comforts of life to the whole of the world's population. It would be possible to give every man both material wealth and the leisure which he needs to realize the full potentialities of his nature and enjoy the full heritage of the civilization of today, if only we spread the knowledge and advance the skills which we now possess. When we stop to consider the enormous productivity of the United States during the war, with fifteen million or more of our most able-bodied men and women withdrawn from the field of production, we can begin to comprehend our potentialities in power and resources. Consider also the speed with which we converted from production for peace to war production. And other industrialized countries performed similar feats under even more adverse circumstances. Consequently we know what could be done in the productions of those things which man needs.

But having the power potential is only the beginning. Ordered human progress requires more. The full appreciation of our freedom requires more. We must possess not only the power, the knowledge, the industry and the skill to work cooperatively for great productive progress, but also we must regulate and control individual and group activities so that they do not react disastrously and destructively upon each other. That is the major problem of the

(Please turn to page 54)

[2] **Sir Arthur Salter, Second Massey Lecture, "Modern Mechanization and Its Effects on the Structure of Society," McGill University, April 18, 1933. Reprinted in *Science and Social Change*, Brookings, Washington, 1939, pp. 317-339.**

free men of our time. The problem of production is a problem of creation. That we have solved. But the second, the problem of regulation in the public interest, is a far more complex and difficult problem. It is the great unsolved problem of our day. The future of man's freedom depends upon his success in making the right solution to this important problem. As John Dewey has said, "The great scientific revolution is still to come. It will ensue when men collectively and cooperatively organize their knowledge to achieve and make secure human values."

Such values as international peace, industrial plenty, physical health and long life for a great majority of people, are among the practical possibilities. To achieve such goals we must think of science and technology in its broadest sense. Science today, it should be remembered, means not merely the physical and biological sciences, but also the social sciences—modern economics, sociology, psychology, statistics and related subjects. These we now seek to develop in a way as nearly objective as the nature of human materials and the available techniques of investigation permit. In our time the highest hope of social advancement is based on a reasoned relationship of man to man, not a haphazard relationship.

Part III

Within our present legal structure we have evolved a certain system of social controls which some regard as unduly inhibitive. But this has developed naturally. No one will deny that it is the government's function to restrain licentious conduct. The excess of those who would prey upon society must be curbed. The police must restrain the highwayman, the housebreaker and the reckless driver. The protection of our property and our safety require it. It may be said that only with such protection may one enjoy the blessings of freedom. And only those who live by preying upon society will question such orderly restraint by the police. But in a highly complex society, the government's functions do not end — and cannot end — with the restraint of these obviously anti-social acts. The government's activities, by popular demand, endeavor to keep pace with our social and economic life. As it becomes more complex, government functions lose their simplicity. Just as some citizens demand the enactment of laws to repress robbery, and property owners obtain protection for their persons, their houses, their chattels and their lands, so also do those engaged in the trades, the professions, and businesses of sundry sorts, seek security in the government's protection against interlopers.

It is in this realm of government control of our economic life that we first face a recognizable challenge to liberty, and to free enterprise. This, too, had a simple beginning. Let us consider the professional man—the lawyer, the doctor, the surgeon, the dentist. Each of these must spend years of study and preparation to attain creditable standing. Is it not reasonable that the state protect him against the unfair competition of quacks and shysters? Naturally, this is done in the public interest as well as in the interest of the professional man involved.

From our country's beginning, the government has encouraged invention by awarding monopoly privileges to those who perfect new and ingenious devices. And those who have been so brash as to question the wisdom of such a monopoly grant have generally been regarded as dangerous characters who would

undermine the foundations of our economic order. But all such grants of special privilege are a phase of government interference in the "free" exercise of economic life.

Another phase of government interference with the free flow of goods and services, which has long had public acceptance, has been the protective tariff. Designed in the days of Alexander Hamilton as a means of securing the home markets for our infant industries, the degree of protection has generally increased in direct proportion to the power and influence of the industries protected. There have been a few minor exceptions. But in the main, the bigger the industry, the higher the protection. Such government assistance has secured our higher prices — and has often enhanced the growth of monopolies other than those predicated upon patents. At least this practice of shutting out foreign goods has given rise to situations wherein one, two, or, at the most, a half dozen firms, dominate certain industries. All such government interference limits the competition which was once regarded as the life of trade. In short, as Dean Cox has said, men who see the virtues of competition for others seek shelter against it for themselves.[3]

And so we progress from one phase of government interference with our economic life to another. It is not unnatural for the workers in such major industries as those just mentioned to unite and demand the government's protection of their rights to bargain collectively. Where the industry is itself maintaining a relatively stable price system, the unions naturally seek to bargain on an industry-wide basis and to prescribe uniform wages for the industry. What could be more natural? And after this has been done, the power and influence of unions reaches a point which the public thinks should be brought under control. Consequently we have the

(Please turn to page 54)

[3] Garfield V. Cox, "Shall We Save Free Enterprise?" *The University of Chicago Magazine*, December 1947, pp. 9-11.

(Continued from page 53)
Taft-Hartley Act, a further restraint upon both employers and employees in the conduct of their relations.

Meanwhile, the farmers have not been asleep. Through equally effective political pressure organizations of the agrarian group has likewise sought and obtained a degree of government price maintenance. In each case government aid has been sought and legislation to effectuate the desired end has been obtained. And who is to say that one group has a better right to such protection than another?

Let us go one step further. If the government is to lend its good offices to support the strong, why should it deny them to the weak? Our humane consideration for the unsuccessful has been a factor in the growing influence of the government in our economic life. In an era of swiftly changing technology, the labor market deals harshly with many persons. Mature men do not leave their homes and friends and learn new trades readily. Consequently, there is loss of jobs, loss of property, a shrinkage of incomes, and a further demand upon the government for safeguards against such social insecurity.

All of this adds to the sum total of government participation in our economic life. It is the manifestation of what has come to be known as collectivism. And it is said to be a challenge to our freedom. Certainly it has produced an economy vastly different from that which obtained seventy years ago. But it is important to note that this situation is being brought about not so much by the advocates of state socialism as by those who have associated themselves together to make common cause for their own private interests and to seek government aid in advancing these ends. Whether in the field of tariff-protected industry, government-supported labor unions, government-supported franchises in the utility field, price-supported farm production and marketing, or social security, it all adds up to the uses of government, or private monopoly, to win for the beneficiaries more income for less service. Such is the character of our political economy at home.

And what do we face abroad? The system of competitive private enterprise in America may be even harder to maintain in the face of growing collectivism in those countries with whom we must trade, or with whom we must compete for markets. It may be impossible to make our system more competitive and restore free markets at home when our domestic firms are compelled to deal with states or quasi-public monopolies abroad.

Part IV

Today, as every day, we face a new challenge. The difficulties that are set for free governments by the developments of technology, and the social and economic change which goes with such developments, are enormous. We must admit that the government has an increasing responsibility. We cannot deny that there must be some controls. The problem is how to shape our domestic policy and our foreign policy so that both business and individual citizens may function with relative freedom and yet will play the game according to the rules. For it is the government's function to prescribe the rules. As Sir Arthur Salter has said: "The forms and methods of government are always adapting themselves; but they are always lagging behind. The pace set by progress in scientific invention and improved industrial technique is too hot for man's regulative control to overtake. And when it lags behind, every new progress in specialized activity is a new danger; every new access of power threatens destruction of what we have more than it promises increase. That is why mechanization is compelling, and will compel, profound changes in the whole social structure."

The constant demand for new laws is an indication of the changes in our economic and social order. Every man has his conception of his

own freedom and just how the other fellow's activities should be curtailed in the public interest. While it is not within our province to say what your list of freedoms and restraints should be, there are certain fundamental liberties which we should all seek to safeguard. We should like to list a few of these and consider with you their present status.

Freedom of religious worship has been one of our cherished liberties since the time of Thomas Jefferson's fight on the established church in Virginia (and since the adoption of the first amendment to the Constitution). We should not overlook it now. You will note that this has meant, as far as the government has been concerned, freedom for all religious groups—not just the Christian groups, or a particular denomination of that faith.

A democratic society could hardly flourish without a great measure of uncoerced personal responsibility among its citizens. It is basic with us that there are limitations to the state's authority. The English fought to defeat absolutism as it was expressed in the Divine Right doctrines of the Stuart Kings. And we in America have expressed the same idea in limiting the power of the states by written constitutions. But all such ideas are again being challenged by new cults of absolutism. The Germans sought an Ayrian paradise. Other Marxist groups champion the classless society. Each thinks that it alone stands for perfection—and, therefore, it alone should be allowed to exist as a guiding force in men's lives. It is a situation in which faith in God gives way to faith in National Socialism, in

Communism, in leader worship, or in the Divine Emperor. All of these put their leader, their party, or their emperor, above the law. All are, in a sense, absolute. In none of these do we find freedom of worship. Nor do we find citizens uncoerced in such states. Let us be on the alert to protect this first of our many freedoms—the freedom of religious worship.

It goes without saying that such other civil rights as free speech, free assembly, and the freedom to publish dissenting views, is in the same category as that of religious worship. Our political faith has championed all of these, with modifications. In times of national emergency, the state has dealt rather harshly with all such personal rights. And now that we seem to face emergencies more frequently—if not continuously—such personal freedom is becoming increasingly endangered. The activities of our Federal Bureau of Investigation are increasing. But what is even more repressive than these government police is a tendency on the part of some self-appointed groups to engage in various forms of witch-hunting.

Part V

For those who deplore the increase in government controls in the economic field, we believe there is little solace. As our economic and social life become more complex our governmental functions are bound to increase, not decrease. This can be easily illustrated by the citizen who may live in an isolated area, such as may be found in parts of Texas or in one of the Rocky Mountain states. Such a person may have the ultimate in personal freedom. He may even extend his conduct to the point of licentiousness. He may get as drunk as he pleases, make as much noise as he pleases, fire his gun in any direction that suits him. He may even kill anything that gets in his way with little likelihood of his being apprehended and confined by the law. But as he progresses from that point of isolation onto the state highway, he may soon find the restraint of government taking a firm hand. By the time he reaches the heart of one of our cities, his conduct will have been decidedly altered or he will have been confined for an extended period of time. And so it is in the field of economic activity; the more complex our economy becomes the greater becomes the need for some regulation.

Now that the government has such an established practice of making regulations in the economic field, it is not likely to relinquish such controls. It is often said that we could not abolish our tariff restrictions without creating chaos in many of our industries. But two years ago we were assured that if we would only get rid of the government's restrictions on prices, the laws of supply and demand would take care of the direction of our production and prices would go down. We got rid of most of our controls, and we are now in the throes of an inflationary spiral which is creating more fear and apprehension than anything that has confronted us within the memory of this generation. Many are now wondering whether we should have been in such haste to abolish some of our war-time controls.

Only last week, one of the country's leading elder statesmen, and a capitalist, urged a congressional committee to roll back prices and hold them; to postpone income tax reduction; to stabilize wages; to restore at least half of the excess profits tax on corporations; and to continue rent controls and to expand production. Of course, he could scarcely have proposed a five-point program that would be more unpopular, politically. The manufacturers don't want price control. Tax payers do want a tax cut. Labor wants no ceiling on wages. And corporations do not want an excess profits tax. But in our refusal to take Mr. Baruch's bitter pill, we may *(Please turn to page 56)*

(Continued from page 55)
invite an economic boom and bust which will be far more disastrous for our economic well-being than anything we have yet faced. Such a collapse would be worse for our free economy—and in the long run, for our personal freedom—than what Mr. Baruch has proposed.

The need is great for better and clearer rules in matters which are already the acknowledged responsibility of the state. The direction of our monetary and fiscal policy, the federal tax structure, spending and debt arrangements—these are the major areas of government responsibility, and today they are all a bewildering hodge podge. The government has plenty to do in these fields of major policy—in prescribing the working rules of our free economy—without dabbling in details of labor contract negotiation, and into the personal beliefs of some citizens.

Part VI

We should not conclude a discussion of this topic without some consideration of our obligations to the rest of the world. Foreign affairs are now our most intimate domestic concern. The immediate and pressing challenge to our belief in freedom and prosperity is in western Europe. Here are people who have traditionally shared our faith in human dignity. These are the nations from whence our forefathers came and in whose traditions our civilization is rooted. Because of the dark shadows cast by the hopelessness, hunger and fear that have followed the Nazi war, they are threatened by Communism. The reconstruction of western Europe is a task from which Americans can escape only if they wish to abandon every principle by which they pretend to live[4].

Communist Russia is counting on an economic collapse in the United States as the signal for its further advance westward. We are, in a sense, already at war with Russia. It has been called the "cold war". That is because we have been waging it by economic pressure and by aid to certain European governments who are engaged in more direct and overt conflict with the Russian satellite nations. The lessons of history should teach us that such economic strife is but the prelude to a shooting war. And if our economy is allowed to collapse our chances of winning, short of a shooting war, are practically nil.

Popular sentiment in the United States today seems to run along three divergent lines: *First*, there is the official sponsorship of Secretary Marshall's plan to aid the western European peoples to get back on their feet—to help them in their efforts to help themselves. This seems to be the prevailing view, since it is not only the policy of the administration but also has the active support of such Republican members of Congress as Senator Vandenburg, Chairman of the powerful Senate Foreign Relations Committee. It is, we believe, the sincere belief of most of those who support this program that only through some such plan of preserving the freedom of these western European peoples will we be able to maintain our own freedom. If all of Europe falls within the Russian sphere of influence, our position of leadership will have been lost and our future security endangered.

The *second* body of opinion in the United States is one which champions the solution of this and all other foreign problems by more direct and aggressive military action. With the greatest Navy in the world, the greatest potential air force in the world, the greatest industrial machine in the world, and with the atomic bomb, we are invincible. Therefore, say these patriots, "What are we waiting for?" We could solve the Russian problem within a few decisive months, so why wait for the Russians to get their own atom bomb and attack us?

We believe, with Henry L. Stimson, that such strong-arm methods would be the worst kind of nonsense. This view results from a hopeless misunderstanding of the geographical and military situation, and a cynical disregard of what the people of the world will tolerate from any nation, however lofty its alleged motives. This militaristic, or jingoistic, theory indicates a wrong impression of the basic attitudes and motives of the American people. Even if it were true that the United States now had the opportunity to establish forceful hegemony throughout the world, we could not possibly take that opportunity without deserting our true inheritance. As Mr. Stimson has said, "Americans as conquerors would be tragically miscast." As such we should be forced to surrender freedom at home. How then could we be its champions abroad.

The *third* body of opinion with respect to our foreign policy is that expressed by Henry Wallace. His goodhearted insistence that nobody can dislike us if we try to like them is naive, to say the least. Of course, we must show good faith in our dealings with Russia. Only by so doing can we leave the door open for Russian good faith toward us. But all of this does not alter the fact that the Soviet leaders have hoped and planned for the day when our economic system would collapse. And the regime which exists in the U. S. S. R., and her satellite states, is one which holds little hope for the future of freedom as we know it. Therefore, the challenge of Russian Communism is a challenge to us, and to our freedom. We can meet this challenge, not by conquering and subordinating the rest of the world to our military might, but by asserting a form of leadership which restores and preserves the dignity of our fellowmen.

The Marshall plan may involve a gamble—a desperate one. But so does any other course we take. And the greatest risk of all comes from inerita—from doing nothing. We cannot drift into security, but only into subjection and slavery. Our leadership and our greatness depend upon some positive program, some forward effort. Let us not forget the old adage: "Eternal vigilance is the price of liberty."

[4] Henry L. Stimson, "The Challenge to Americans," *Foreign Affairs*, October 1947. Reprinted for the Committee for the Marshall Plan, pp. 1-11.

Partners in Research

(Continued from page 21)

making available to other countries an integrated non-profit, non-governmental, industrial research and experimental engineering service on a broad basis.

The Foundation recognizes the essential role that industrial technology and research must play in economic development and in the improvement of living standards of people everywhere. The view is shared by leaders in government, industry, and banking throughout the world.

Objectives

Services of the International Division are available to foreign private industries, foreign governmental bodies, central banks, planning and development commissions, and also to similar domestic entities seeking new sources of products and materials for importation, and those seeking to adapt their processes and products to the requirements of foreign markets and manufacture. The principal objectives of the division are:

1—To undertake technological audits of industries within foreign countries for responsible private or government organizations.

2—To conduct surveys and laboratory research on the natural resources of foreign countries and to make recommendations for their utilization.

3—To study, recommend, conduct, and supervise research leading to the improvement of existing industries, the establishment of new ones, and the general improvement of health, nutrition, productivity and standard of living of other peoples.

4—To encourage and make possible necessary research and development work by foreign private industry.

5—To provide specialized technical, engineering, and scientific assistance for development of industries and improvement of industrial operations.

6—To assist and promote development of trained technical personnel, research facilities, and industrial process control in all countries.

7—To assist in establishing and operating research organizations in countries where these organizations can be of value.

Background

The Foundation first entered the field of international service in 1942 when it was commissioned by the Argentine Corporación Para la Promoción del Intercambio to make a full scale technical and economic survey to Argentine industries. This study was designed to indicate specific steps for modernization of existing industries and to outline research programs for the ultimate better utilization of natural resources for the economic improvement of the Republic and its people. New Argentine factories, institutions, and other evidences of industrial progress, based upon recommendations of a published report of the survey, have since been established within the Republic.

In 1944, the Foundation was commissioned by El Banco de México to make a similar survey of selected industrial groups and resources of the Republic of Mexico with special emphasis on the development of fibers, hides and leather, forest products, and solid fuels. Although this basic survey was completed and published at the end of 1945, numerous special research projects resulting from it were continued well into 1946. In April, 1947 the Banco de México arranged for a new, expanded program to be conducted by the Foundation. An even more extensive study of industry and resources has been requested by the Mexican Federal Government as an aid to Mexico's industrial planning.

In additon to the Technological and Economic Survey of Argentine Industries and the Technological Audit of Selected Mexican Industries, several problems dealing with specific industries have been solved. Among these are: (1) the development of a method of producing a stabilized extract of cascalote tannin for the leather industry; (2) the development of a rapid method of analysis of the alkaloid content of the bark of young cinchona trees for the selection of plants for quinine production; (3) the design of a plant for the continuous extraction of quinine from cinchona bark; (4) technical and engineering studies for the improvement of operations of a glass factory in Monterrey; and, (5) development of by-products from the wastes of henequen fiber production, two of which may be of major industrial importance to the Yucatan peninsula, a "single product" state.

New projects now in progress include evaluation of a packing house by-products industry in Mexico; a comprehensive study of fats and oils native to Mexico as raw materials for both new and established industries; evaluation of fluorspar deposits in Mexico with the view towards their beneficiation; and, the stabilization and nutritional improvement of the tortilla base (masa).

Establishment of a Mexican technological research institute actively encouraged by the Foundation is nearing realization. Patterned after similar organizations in the United States this institute is expected to provide a service to industry and to government and to supply a much needed link in the industrial development program of Mexico.

Facilities

The International Division is uniquely equipped with a staff already familiar with many of the specialized requirements and problems of research in other countries. To further implement the usefulness of this background there is available for specific problems a staff of more than 400 technologists in the research division of the Foundation. These facilities are augmented by the services of many other research organizations, engineers, consultants, universities and similar entities that have made their facilities and personnel available. Thus it is possible to investigate and develop resources and industrial opportunities within a for-

eign country by making available to it services in practically every field of engineering (mechanical, electrical, process, chemical, metallurgical, etc.), in agriculture, in foods and nutrition, in minerology and geology, in ceramics and in others.

Magnetic Recorder Division

The Foundation has continued to pursue a very comprehensive program of research and development in the field of magnetic recording. The activities range from a study of specific manufacturing problems encountered by industry to basic research in the nature of ferromagnetism. The scope of this research program is wide because of the range of commercial applications in which the licensees have shown interest. In some applications high quality is of paramount importance with the manufacturing cost a secondary consideration. In other applications, cost is the major factor. Exacting performance requirements are also encountered in the use of magnetic recorders as scientific instruments for the recording of signals other than speech and music.

During the past year considerable attention has been given to the improvement of the recording medium and to the development of new magnetic recording media. An improved magnetic powder has been developed which has proved suitable for coating paper and plastic tape as well as motion picture film. This powder gives very good performance at tape speeds of 8 inches per second and satisfactory performance for speech and music has been obtained on 35, 16, and 8 mm motion picture film. Research has also continued on magnetic wire and optimum magnetic characteristics for 0.004 mil wire have been established.

A sizeable program has also been in progress on the design of recording heads for round and flat wire, flat tape, magnetic coatings on motion picture film, and electroplated films on metal bases. Suitable magnetic drive systems and electronic drive systems for use with these recording media and heads have also been designed.

A good quality magnetic recorder has recently been completed to demonstrate the Foundation's developments in the field of magnetic tape recording. In this machine the tape is driven at 8 inches per second and very satisfactory quality for both speech and music is obtained.

Experimental machines have also been built for showing the performance of magnetic sound on 35, 16, and 8 mm motion picture film. Demonstrations of these machines have been given at a number of technical society meetings and a number of papers have been presented on magnetic sound from motion pictures as well as on our other phases of magnetic recording research.

The study of magnetic recording phenomena has necessitated the design and construction of specialized laboratory instruments. Among these *(Please turn to page 60)*

(Continued from page 59)

is a 60 cycle hysteresis loop tracer which permits measurements of magnetic characteristics of various types of recording media with good accuracy. This instrument presents the hysteresis loop on the screen of a cathode ray tube. During the past year modifications have been made to improve this instrument, principally increasing the magnetizing field to which the sample is subjected.

Public Service Activities

(It is the general public that benefits directly from the research sponsored in the Foundation laboratories by the various companies, organizations and government agencies. Recognizing its responsibility as a public service institution, the Foundation has continued to expand its special service laboratories and to broaden its services to the public.)

A-C Network Calculator Laboratory

For more than two years, this laboratory has served very successfully the utilities and electrical manufacturing companies of the midwest. During this past year, the calculator was in use 238 days, with 12 days reserved for maintenance and extension of the facilities. Participating companies used the calculator for 214 days, with non-participating companies using it 24 days.

Seventeen participating companies originally financed the installation and operation of the network calculator. Two new companies have been added to the number of participating companies using the network calculator, increasing to 19 the number of participating companies.

Two full-time operating engineers are employed to assist in the studies. The calculator laboratory has gained national attention and has recently been used for graduate instruction under a Fellowship plan provided by industry. An excellent group of graduate students in the power systems field has been attracted to the laboratory.

Equipment for the transient analysis of power systems is now being added. A recording table invented and designed by a former Foundation staff member has contributed greatly to the accuracy of the board and to the speed of recording data.

Riverbank Acoustical Laboratories

On February 1, 1947, the Foundation assumed management of the Riverbank Acoustical Laboratories at Geneva, Ill. These laboratories provide an important extension of our facilities with additional equipment for studying sound transmission of windows, doors, walls; equipment for hearing aid and audiometer research and development; and a good reverberation chamber.

During the final six months of this fiscal year, 96 studies were conducted for companies manufacturing acoustical equipment and materials.

Precision Gage Laboratory

This laboratory, operated before the war by the Foundation, and maintained and augmented during the recent war years by the Ordnance Department of the United States Army, is again in operation. Housed in a specially constructed air-conditioned and constant temperature section of the Engineering Research building, it continues to serve the tool, gage, and metal fabricating industry. Operated as one of a number of special service laboratories of the Foundation under the Armour Plan for Industrial Research, the facilities of this laboratory are being used by industry for the convenient calibration of precision measuring standards, instruments and manufactured components.

A course in precision mechanical measurements offered this fall makes this laboratory doubly useful to industry, Illinois Institute of Technology, and Armour Research Foundation.

National Registry of Rare Chemicals

First established in 1942, the National Registry of Rare Chemicals continues to render an outstanding service. More than 5,000 inquiries for information on rare chemicals were received during the past fiscal year. We were able to fill more than two-thirds of these requests from our own files.

Source data on approximately 2,000 new chemicals were added to the files, bringing the total number of chemical compounds listed in the files to 10,500.

Ohmite Laboratory of Precision Electric and Magnetic Measurements

The original contribution from the Ohmite Manufacturing Company and additional support from general Foundation funds have developed this laboratory to a position unexcelled by any non-governmental laboratory in this country. This laboratory is serving a very useful function to the Foundation, to Illinois Institute of Technology, and to industry in this area.

Seven industrial sponsors made use of the laboratory during the past year and graduate instruction in precision measurements was provided for students at Illinois Institute of Technology.

Industrial Research Fellowships

During the past year the Foundation established a number of Industrial Research Fellowships which provide the recipients with training in the techniques and procedures of industrial research, and a graduate educational program which would lead, upon successful completion, to the degree of master of science in the field of major specification at

(Please turn to page 62)

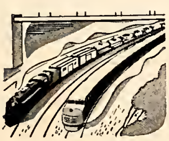
We're not so hot on POGO STICKS

Lots of people like to play jack rabbit. Still, as a way of going to work every morning, we don't see much of a future for Pogo Sticks. Not even *aluminum* Pogo Sticks.

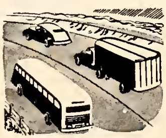
But mention any other means of locomotion or transportation and our aluminum "Imagineers" get a gleam in their eyes. After all, what is more logical than vehicles made of aluminum? Less weight to move. More payload.

We turned our imagination loose on that idea years ago . . . then engineered our thinking into trains, trucks, planes, ships. Alcoa's Development Division has a staff of "Imagineers" who think of nothing else but better ways to transport people, products, and materials by using aluminum. Actually, we have *four separate* staffs of transportation engineers, one each on railroads, highway vehicles, ships and aircraft.

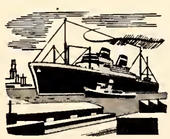
Whatever you do after college, you'll benefit from that. If you go into transportation, these Alcoa engineers will be working with you to cut costs, speed schedules, improve facilities. Or if you choose some field of production, they'll be helping to transport your materials and finished goods cheaper and faster. ALUMINUM COMPANY OF AMERICA, Gulf Building, Pittsburgh 19, Pennsylvania.



Passenger streamliners, refrigerator cars, hopper cars and tank cars built of Alcoa Aluminum are serving American railroads.



Alcoa Aluminum is finding more and more uses in buses, trucks and trailers. Yes, in passenger car manufacture, too.



Newest thing in shipbuilding is the aluminum superstructure, developed by Alcoa with marine architects and engineers.

Ever since Kitty Hawk, Alcoa has worked with the aircraft industry in developing better aluminum for better planes.

ALCOA FIRST IN **ALUMINUM**

(Continued from page 60)
Illinois Institute of Technology.

These research internships are unique in that they provide experience in our laboratories on actual existing research problems as well as graduate instruction and graduate research.

Five appointments were made during the past year, and there is every indication that this program will develop especially well qualified men for the research laboratories of industry and for our own laboratories.

Crystallographic Studies

In connection with a fundamental research project designed to study the crystallographic structure of organic compounds, the Foundation plans to expand this study and make available a system for the checking of data from other laboratories which will be collected, checked, edited and published.

Eighteen additional compounds were studied this past year to determine the physical properties of common important organic compounds, including a summary of the literature, solubility and crystal habit, polymorphism, crystal geometry, crystal optics and application of fusion methods.

Illumination Laboratories

The Physics Research department of the Foundation continued to operate the Illumination Laboratory at Glesner House. This laboratory was of considerable value in connection with numerous research projects and studies and also served for educational purposes in connection with the academic program of the Chicago Lighting Institute and Illinois Institute of Technology.

It is expected that the usefulness and value of this laboratory will increase in the near future when its facilities are moved to the Technology Center campus.

Engine Research Laboratory

Nationwide recognition has been accorded this neutral laboratory in the field of lubricants, fuels and internal combustion engines. The addition of considerable new equipment and the rearrangement of its facilities has greatly enhanced its value. The year has been marked by a rapid increase in the volume of research studies.

Dust Analysis Laboratory

Maintained largely for the Smoke Department of the City of Chicago, this laboratory has continued during the year to render an outstanding public service by providing a monthly analysis of dust from 24 stations in Chicago. These studies are part of the Chicago Smoke Abatement Program.

Management of Research Seminar

More than 100 research executives from the Chicago area attended this *(Please turn to page 64)*

"GLASS SURE MAKES BETTER COFFEE!"

Thousands of families say their next coffee-maker will be glass. Why? Because they like their coffee just right! Glass lets you *see* and control the strength of the brew. Glass never alters flavor, even when coffee stands and is reheated throughout the day in your home or in a restaurant. And you can see at a glance when a glass coffee-maker is clean...so your next brew will be as rich and amber-clear as the first.

There are five excellent glass coffee-makers on the market today. And everyone of them uses Pyrex brand glass parts made by Corning. The reason? Because Corning makes these glass parts to close tolerances, with proper sidewall thickness, of uniform high quality. And Corning makes glass that can stand heat and cold without breaking.

Everybody benefits today from Corning's knowledge of glass. You get a better cup of coffee. Better food cooked in Pyrex ware. Better soup processed in Corning glass piping. Better vitamins extracted with Corning laboratory ware. Better light from bulbs and luminous tubes made from Corning's glass.

In all, Corning makes about 37,000 items in glass. Many of them have been applied in fields once held by other materials. Glass gets into new jobs because Corning uses it as a material of unbounded possibilities. Perhaps some day, in the business you select, glass will be able to cut costs, improve processes, or add to the saleability of your product. That's the time to remember us. Corning Glass Works, Corning, N. Y.

IN PYREX WARE AND OTHER CONSUMER, TECHNICAL AND ELECTRICAL PRODUCTS ▸

CORNING
means
Research in Glass

(Continued from page 62)
one semester seminar course in the problems of research management. The seminar was given in cooperation with Illinois Institute of Technology and received considerable nationwide recognition. A number of men prominent in the research management field served as leaders of the seminar. It is expected that this course, or an extension of it, will be given again within the near future.

Foundation Sponsored Research

(The maintenance of a fundamental research program is of greatest importance in the technical and professional development of the staff. During the past year, 27 fundamental research projects were sponsored by the Foundation from its general funds. Most of the results of the Foundation sponsored projects, abstracted and published in this report, have been or will be published or announced in scientific meetings.)

Abrasion Resistance

Foundation sponsored work has been carried out as a supplement to industrially sponsored projects dealing with abrasion testing research. Metallographic and microhardness studies have been made of various abrasion resisting alloys in order to obtain a deeper understanding of the nature of abrasion obtained with different types of abrasives. Tests have been made with crushed feldspar, cast iron grit, crushed quartz, and silicon carbide.

Bomb Tests and Photographs

This project was established for the purpose of making a fundamental study of various phenomena associated with the "Munroe Effect" in the detonation of shaped charges. During the current year studies have been made on an additional 132 bombs at Camp McCoy, Wis., with particular investigation of the following:

(a) *Penetration phenomena*— Penetrations up to more than 20 inches of steel have been obtained and sections of specimens and photographs made.

(b) *Seismic waves set up by means of a shape charge*—This work, in conjunction with the seismic work in the Antarctic, has given rise to a method of utilizing the shaped charge for the purpose of eliminating the drilling of holes for the explosive charges in geophysical seismic operations. The superiority made possible in interpreting records produced as well as reduced costs and time consumed in prospecting for oils, has elicited the keen interest of oil companies.

(c) *The deceleration of the jet material by means of the Mock angle and the resultant curvature of the shock wave*—This is a new method of measuring deceleration of fast-moving materials, and it is the first time that the deceleration of the Munroe jet has been measured.

Chemical Analysis by Nuclear Induction

Work has been started on the development of equipment and techniques utilizing nuclear magnetic resonance effects as a means of making instantaneous chemical analyses. The sample to be analyzed is subjected to varying frequency radio excitation while in a strong magnetic field. The elements are identified by resonant absorption frequencies.

Crystallographic Studies

Eighteen additional compounds have been studied in the past 12 months in the program of determining the physical properties of common important organic compounds.

The following outline is covered for each compound: summary of the literature, solubility and crystal habit, polymorphism, crystal geometry, crystal optics, and the application of fusion methods.

The compounds covered were:

Pyrogallol, Pyrocatechol, p-Phenylene Diamine, Hydroquinone, p-Methyl aminophenol Sulfate, Semicarbazide Hydrochloride, Diphenyl Acetamide, Dicyandiamide, Thiourea, Azobenzene, Theobromine, Theobromine Hydrochloride, Uracil, 1, 3, 5-Tri-p-chlorophenylbenzene, 1, 3, 5-Tri-p-fluorophenylbenzene, alpha-Pyridine Sulfonic Acid, beta-Pyridine Sulfonic Acid, and gamma-Pyridine Sulfonic Acid.

Future plans include the organization of a system whereby crystallographic data from other laboratories as well will be collected, checked, edited, and published. A number of crystallographers have indicated their willingness to cooperate in such a project.

A second paper has been written on the Kinetics of Crystal Growth. This work will be continued to increase our knowledge of the mechanism of crystal growth and to develop analytical methods based on measured rates of growth.

A paper is in preparation covering the phenomenon of boundary migration and recrystallization of pure solid phases. Several additional compounds showing this effect have been found.

Diffusion in Alloys

A project is set up to study the diffusion rates of metals using a thickness tester developed at the Foundation.

Extreme Pressure

This project includes several different programs in the field of moderate and extreme pressure phenomena. Numerous extreme pressure techniques and new types of extreme pressure equipment have been developed for the fundamental study of these pressures upon physical and chemical properties of matter, and the facilities in the high pressure laboratory have been greatly expanded.

(a) *Cavitation and the magneto-striction oscillator*—The Foundation is cooperating with Dr. H. Neckles of Michael Reese Hospital in using the magneto-striction oscillator to produce hemolysis in blood. Excellent progress is being made in this work.

(b) *The development of an extreme pressure method of determining the hardness of materials under pressure*—In addition to solidification pressure method for identifying the crude from which an oil is produced, an extrusion pressure method has been developed for determining

(Please turn to page 66)

Served by Mr. & Mrs.
Gregory Peck
in the Modern Bar of their Santa Monica Home

PLAYTIME...for GREGORY PECK, *and You!*

WHETHER IT'S GREGORY PECK, loafing at home after a day at the studio—or you, in your own playtime moments—both will find Pabst Blue Ribbon always a pleasant, friendly companion.

That ever-faithful, real beer flavor you enjoy in Pabst Blue Ribbon was achieved by 104 years of pioneering in the *Art of Brewing* . . . and the *Science of Blending.*

By tasting, by comparing, you will understand why millions the world over have settled down to the real beer enjoyment and satisfaction that come only with blended, splendid Pabst Blue Ribbon.

33 FINE BREWS BLENDED INTO ONE GREAT BEER

Pabst
Blue Ribbon

Tune in the EDDIE CANTOR show every Thursday night over N B C.

(Continued from page 64)

the hardness of solidified liquids up to that of metallic copper.

(c) *Liquid tensions*—Preliminary studies have been started in the investigation of liquid tensions in which actual tensions of as much as 15,000 psi have been developed in a column of oil ½ inch in diameter and 10 inches long. It is believed that this work will lead to a better understanding of the fundamental nature of liquids.

(d) *Phase Diagram* — Considerable progress has been made in phase diagram studies of several materials under extreme pressure.

(e) *Pressure Windows*—A method has been developed for mounting pressure windows to withstand explosion pressures of 100,000 psi and further development is now being sponsored on a government contract for application to a government contract. However, development has been made in the use of pressure windows for pressures up to 500,000 psi.

(f) *Special high pressure bombs* —Much progress has been made on the design and construction of a very high pressure bomb for working at pressures in excess of 1,000,000 psi and at elevated temperatures. The basic design is so novel and conveniently adaptable to a wide range of operating conditions and different processes that it has wide commercial possibilities as well as scientific merit.

Fluid Flow and Heat Transfer in Artificially Roughened Pipes

The objective of this fundamental research program is to clarify and increase the knowledge of heat transfer and fluid flow through artificially roughened pipes by systematic measurements of velocity distributions, pressure drops, heat transfer, temperatures, and roughness characteristics of the boundaries, for a wide range of Reynold's numbers, pipe sizes, and types of accurately reproducible roughnesses. In amplification of the work of Nicuradse, who used sand roughened pipe interiors, under the present program, geometrical roughnesses will be investigated, which are generated by cutting spiral grooves of quadratic cross-section into the inside of four-inch pipes. Geometrically similar roughnesses will be tested.

Fundamental Mechanics Research

The object of this project is the study of the effects of tri-axial stresses on failure of material and in partciular to evaluate the influence of the intermediate principle stresses. Evaluation of the effect of embrittlement will be made by temperature control.

A type of material, new to the field of stress studies, has been developed and found satisfactory for providing specimens which permit controlled tri-axial testing conditions. Testing procedure and equipment are in the process of development and construction.

Fundamental Research in Ferromagnetism

More information concerning the relation between domain structure and the magnetic properties of ferromagnetic materials is needed to resolve apparent contradictions between theory and experiment. Hence, attempts are being made to develop experimental techniques for making microscopic studies of domains at the surface of a ferromagnetic specimen. Empirical studies of the mathematical form of normal and cyclic B-H curves is also being carried on with the hope of correlating the results with other magnetic properties of ferromagnetic materials.

Hardenability Tests

This project is intended to determine the base hardenability of pure iron and carbon alloys as a means of predicting the effect of alloying elements.

Heat Transfer

This project is to determine (a) heat transfer between a coiled tube and a liquid flowing therein, and (b) the influence of the properties of a liquid and the dimensions of a flat plate on the heat transfer by free convection from a horizontal plate to a liquid. A paper is in preparation on the first part of this program and equipment is being assembled on the latter part.

High K Materials

Recently developed ceramic materials have dielectric constants up to several thousand and high dielectric strength, with resulting high energy storage per unit volume. In this project these materials are being studied to determine their applicability to the field of electrical engineering for uses such as electrostatic generators or motors, electrostatic sound recording, microphone and phonograph pick-ups, loud speakers, and electrostatic measuring instruments.

Magnesium Alloys

A method of determining aluminum in magnesium alloys has been devised consisting mainly of dissolving a sample in HCL to which NH_4Cl is added, adjusting the pH to a critical value of 3.37, and titrating the sample using NH_4OH until a second critical pH of 5.37 is reached. These pH values represent the beginning and end of the precipitation of aluminum hydroxide. The amount of NH_4OH is related quantitatively to the stoichiometric amount of aluminum present.

The method requires about 25 minutes and is accurate to at least $\pm$ 3 per cent of the measured value. The range of percentage which may be analyzed by this method is 0-12 per cent aluminum.

Materials for Magneto-Strictive Oscillators

Two completely new and different types of materials have been conceived by members of the Electrical Engineering Department of A.R.F. for use as elements in magneto-striction oscillators. So far, only preliminary tests which have been made on these materials, indicate that they will give improved performance in

the high frequency range, and that certain components for magneto-striction devices to be used at high frequencies can be simplified in fabrication by their use.

Parmly Anechoic Chamber

The Foundation has sponsored a project to measure the performance of the anechoic (echo-less) chamber of the Parmly Laboratory for Auditory Research. Development of special sound sources and of unusual measuring techniques were necessary. The inverse square law was measured from 60-24,000 cycles and the effect of the proximity of the wedge-shaped acoustic treatment on the sound radiation of a loudspeaker was obtained. Data were also taken on the sound transmission of the walls. The performance of the room was found to be excellent for the kind of measurements for which it had been constructed.

Residual Stresses

This research consisted of an attempt to determine residual or locked-in stresses in steel plates and structural steel members by applications of the magneto-striction effect. The method, though theoretically sound, was found to be subject to large errors due to hysteresis effects in the steel.

Solidification Under Pressure

This project is to determine the effect of pressure on transformation of steel.

Use of the Betatron

Arrangements were made for our use of the Betatron in Rock Island Arsenal, and several different investigations have been undertaken:

(a) The effect of the radiation of the Betatron on magnetically recorded records.

(b) The possible use of the Betatron for obtaining penetration and moving picture records of small arms mechanism.

(c) The effect of such radiation in the genetic study of some living organisms.

(d) The use of the Betatron for metallographic penetration studies.

Torque Meter

A compact, accurate, and reliable torquemeter, operating on a new principle, magnetostriction, has been developed and units are now under construction for industry at Armour Research Foundation.

Tests made on stationary and rotating shafts have conclusively verified the theoretical predictions. The test program included tests on temperature sensitivity, various methods of improving torque-sensitivity of surface films of power shafts, simplification of electronic circuit, and reduction in size of all parts. As a result of this program, better alloys have been found, and improved pick-ups and circuits were developed.

Two additional patent applications were filed and arrangements for commercialization are under way.

Transformation Curves for 18-8 Stainless Steels

This project is to determine isothermal transformations in a new type precipitation-hardening stainless steel. The phase changes are followed by changes in the resistivity of the specimens. A special furnace has been built to maintain constant temperature over the length of the specimen during the isothermal treatment. The specimen is heated for solution treatment by an alternating current and the temperature is determined by thermocouples. The equipment has been built, and runs at several temperatures have been made.

Transformer Insulation

An investigation was made of the factors influencing the aging of transformer insulation in parallel with similar investigations in other laboratories. The result of these investigations was submitted as a report to the American Institute of Electrical Engineers by the Subcommittee on Transformer Insulation. The tests, now completed, checked excellently with the results obtained in other competent laboratories.

Vacuum Treatment of Metal

The effect of treating molten alloys with moderate vacua for various lengths of time is to be studied under this project.

Midwest Power Conference

(Continued from page 23)

(a) Telemetering of Power, Reactive Power, and Similar Quantities. Nathan Cohn, District Manager, Technical Division, Leeds and Northrup Co., Chicago.

(b) Telemetering Channels. R. J. Donaldson, Commonwealth Edison Co., Chicago.

(c) Supervisory Control. A. P. Peterson, President, Control Corporation, Minneapolis.
Speakers: S. M. Dean, Chief Engineer of the System, Detroit Edison Co.
Henry T. Heald, President, Illinois Institute of Technology.

2:00 P. M. Supervisory Control and Telemetering. Chairman: E. H. Schulz, Armour Research Foundation of Illinois Institute of Technology.

3:30 P. M. The Gas Turbine. Chairman: John T. Rettaliata, Illinois Institute of Technology.

(a) Progress Report on the Coal-Burning Gas Turbine. J. I. Yellott, Director of Research, and C. F. Kottcamp, Ass't. to the Director, Locomotive Development Committee, Baltimore.

(b) Why So Many Gas Turbine Cycles? L. N. Rowley, Managing Editor, and B. G. A. Skrotzki, Associate Editor, POWER, New York.

(c) Operation and Test Experience with an Experimental 2000-hp Gas Turbine. T. J. Putz, Westinghouse Electric Corp., Philadelphia.

3:30 P. M. Conductors. Chairman: K. W. Miller, Armour Research Foundation of Illinois Institute of Technology.

(a) Development of Requirements for Copper Wire Connections. Frank E. Sanford, Director of Research, Copper Wire Engineering Association, Chicago.

(b) Synthetic Rubbers and Resins as Insulation for Wires and Cables. J. T. Blake, Director of Research, Simplex Wire and Cable Co., Cambridge, Mass.

Vocational Interests . . .

(Continued from page 25)
in preparation for quite varied vocational careers. We know that graduates of this department enter such different kinds of work as sales and engineering, and it may be presumed that the students enter the department with different goals in mind.

In order to carry this investigation further, it was decided to compare the fire protection freshmen with a number of the alumni. With the cooperation of Professor John J. Ahern, chairman of the department of fire protection engineering, the *Preference Record* was sent to nearly 300 alumni of the fire protection department who had indicated an interest in the study. Approximately 150 have returned the inventory, and their results may be compared with those of the students. The respective profiles of these two groups are shown in Figure 4.

When one compares the scores of the fire protection students with the scores of alumni still in fire protection work, certain differences in interest become apparent. The alumni show a greater interest in mechanical, persuasive, and social service activities, and considerably less interest than the students in computational, scientific, or clerical activities. Other differences shown on the profiles are insignificant.

A small number of the alumni indicated that they are not now engaged in fire protection work, but have entered other types of activity. Although this number is small, the interest patterns of this group were compared with the alumni still active in fire protection. The profiles of the two groups, shown in Figure 5, indicate very striking differences in preference. Those alumni who are no longer in fire protection work exhibit much greater interest in computational, literary, musical, and clerical activities, and much less interest in mechanical and scientific activities. Almost exactly the same differences are found when this group is compared with the freshmen students, as shown in Figure 6. The alumni no longer in fire protection work are less interested in mechanical and scientfic activities, and more interested in computational, literary, and musical activties. They are also more interested in persuasive and social service activities than are the freshmen. Whether still in fire protection work or not, the fire protection engineering alumni are more interested in persuasive and social service activities, and less interested in scientific activities, than the freshman fire protection engineering student.

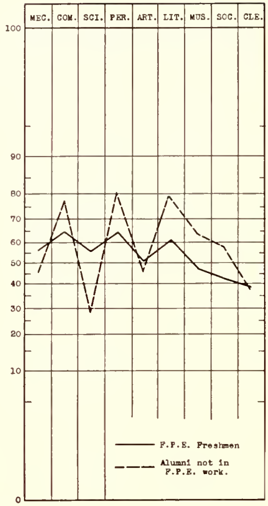


Figure 6. Percentile ranks of mean *Preference Record* scores of fire protection engineering freshmen and alumni no longer in fire protection engineer work.

The alumni who are now in fire protection engineering work also indicated whether their work is primarily sales, administrative or engineering in nature. The scores of these three sub-groups are shown in Figure 7. It is apparent that these three groups differ quite widely between themselves, and that they are quite different in some respects from the freshmen.

Although all three of the groups are higher in persuasive interest than the student group, the salesmen are much higher in this trait than the other two. Both the sales and the engineer alumni groups have higher social service interests than the students or the administrators, and also lower computational and clerical scores. In mechanical interest the sales alumni do not differ significantly from the students, but the administrators are considerably higher, and the engineering group is still higher.

In short, the average freshman student in fire protection engineering, less scientific in interest than other student engineering groups at Illinois Institute of Technology, and

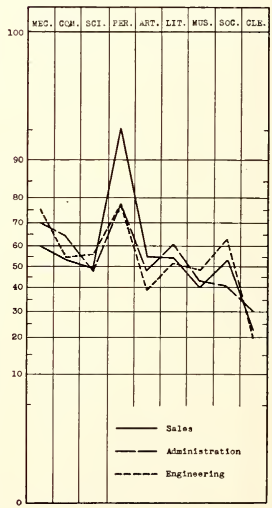


Figure 7. Percentile ranks of mean *Preference Record* scores of fire protection engineering alumni now in sales, engineering or administration.

with no really strong preferences for any of the areas measured, is most clearly interested in working with figures and with people. The alumnus who is now in sales work is no more scientific in interest than the student, but has a much greater interest in working with people, and a greater interest in work which is of benefit to others. The alumnus now in engineering work has a greater interest in working with people, and a strong interest in work which will be of benefit to others. Although apparently no more scientific in interest than any of the other groups, he has much stronger interest in work which concerns machines and mechanical activities.

The alumni-administrator group differs the least from the average fire protection engineering freshman, showing only somewhat higher interest in mechanical activities and those requiring direct verbal contact with others.

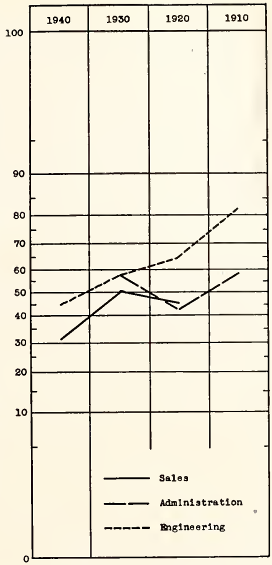


Figure 9. Relation of scientific interest to date of graduation.

In attempting to evaluate these results in order to use them more effectively in the guidance of students, there arises the problem of determining whether the alumni entered sales or engineering because they were the kinds of persons indicated by these scores, or whether they developed these interests as a result of the type of work which they were doing.

Although the groups are too small to permit definite conclusions, we felt that some evidence on this point might be obtained by comparing the scores of the alumni who had been employed for varying periods of time. Here it was necessary to depend upon the date of graduation as an indication of the length of employment in these fields. This is probably sufficiently accurate for the sales and engineering groups, but it is probably not accurate for the administrator's group because most people do not obtain managerial responsibilities until after a period of employment in other capacities.

For each of the alumni groups the scores were arranged in order of the date of graduation, and arbitrarily classified by four dates: those who had graduated between 1910 and 1919, 1920 and 1929, 1930 and 1939, and since 1940.

The literary, artistic, and musical scores on the *Preference Record* are constant for all alumni groups, and do not differ greatly from the student scores. The computational and clerical interests differ from the scores of the students, as shown above, but, with one exception, do not show any trends within the three groups. The exception is the rating on clerical interest of the alumni now in sales work; here there is found a steady rise in clerical interest the longer the individual has been a graduate.

(Please turn to page 70)

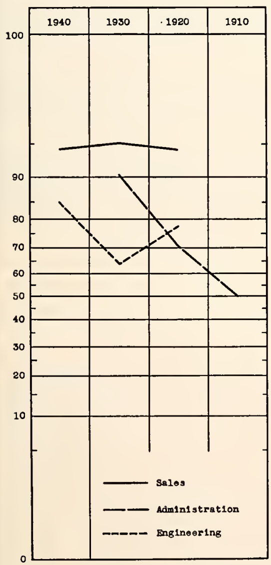


Figure 8. Relation of mechanical interest to date of graduation.

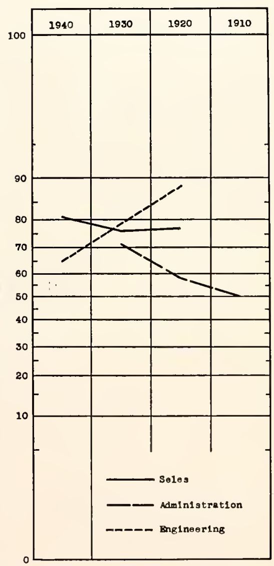


Figure 10. Relations of persuasive interest to date of graduation.

(Continued from page 69)

The changes in score on mechanical interest are shown in Figure 8. The sales group shows only minor and unimportant changes in this score, but both the administrators and the engineers exhibit definite changes. The engineers indicate a marked increase in mechanical interest, while the administrators show an equally sharp decrease in such activities.

The engineers show a steady increase in interest in scientific activities, as shown in Figure 9. The differences found for the administrators do not reflect a consistent change. The scores of the sales groups, however, seem to indicate some trend toward an increase in scientific activities.

Changes in scores in persuasive interest are shown in Figure 10. In all three of the age groups the salesmen have exceptionally high persuasive scores. The engineers begin with lower scores than either the salesmen or administrators, and show a declining trend the longer they have been graduated. The administrators show a sharp and steady decrease in such interests.

Figure 11 shows the changes found in social service interest. The administrators are low at all age levels, but both salesmen and engineers show a steady increase, with the rate of increase somewhat sharper for the salesmen than for the engineer.

Recognizing again that the results must not be considered too definite because of the small numbers involved, it may nevertheless be possible to draw some tentative conclusions from these data. It seems at once apparent that the freshman students in fire protection engineering are a more heterogeneous group than the students in other departments. Those students who continue in fire protection work tend to enter one of two rather different types of activity, sales or engineering, although the sales work in this field is frequently closely related to engineering. About one-third of them may look forward to administrative responsibilities beginning ten years after graduation.

Those with very high persuasive, and very low scientific and social service scores tend to enter sales;

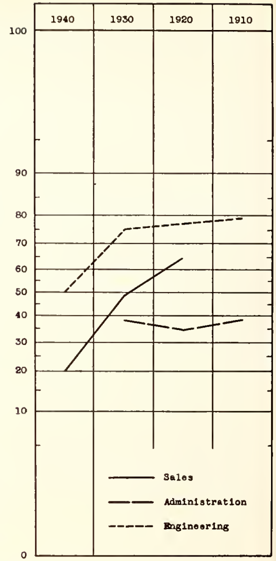
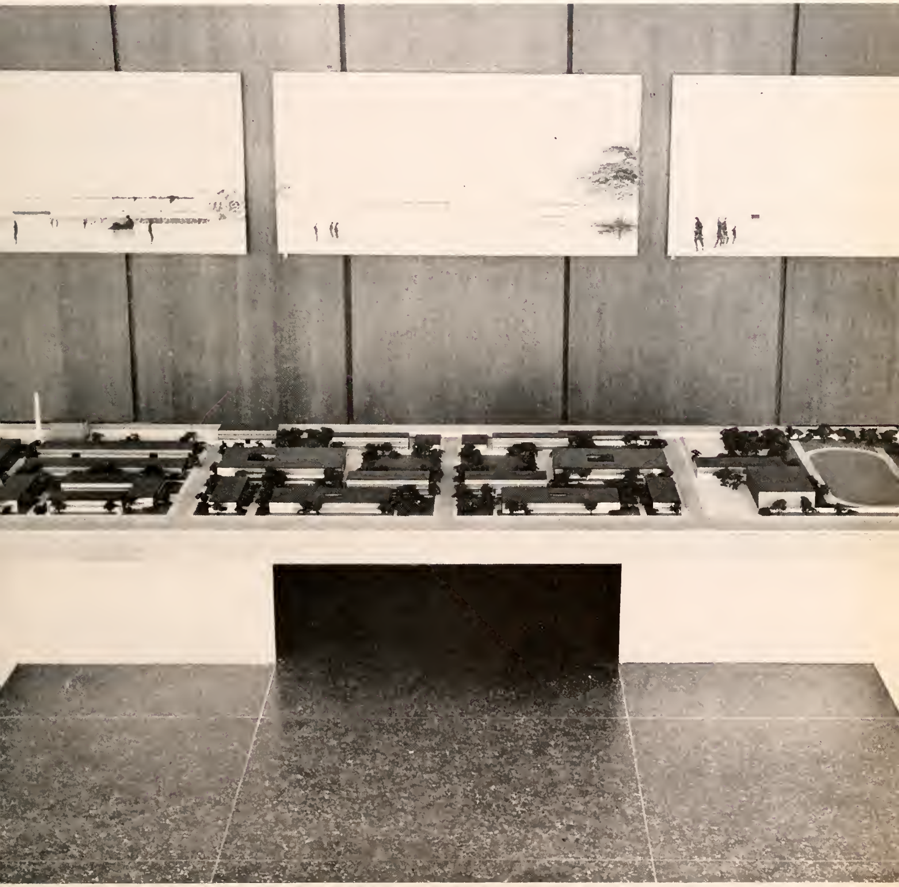


Figure 11. Relation of social service interest to date of graduation.

those with high mechanical, scientific, and social service scores, and low persuasive scores, tend to enter engineering activities. Those with high computational, literary, musical, and clerical interests, and low mechanical and scientific interests, tend to leave the fire protection field to enter other occupations.

From these results it also appears that those who later achieve administrative responsibility quite quickly approach the average in each of the interest areas measured. One individual who has examined these data interepreted this to mean that administrators are not interested in anything. We feel that a better interpretation is that the administrator has broad responsibilities, and that his interests are thus necessarily less sharply differentiated between one area and another. An additional possibility, of course, is that managerial interests take a form not measured by the *Preference Record*.

ILLINOIS TECH
ENGINEER



MAY, 1948

IT TAKES EXPERIENCE TO SKIM THE SURF AT
40 miles an hour on one foot!
...and Champion NANCE STILLEY agrees that in water skiing—and in cigarettes too...
"EXPERIENCE IS THE BEST TEACHER!"
In twisting slaloms ...in tricky jumps ...this petite young Cypress Gardens aquamaid is in a class by herself... a champion many times over.
You watch her and you *know* Nance Stilley has plenty of experience. Her cigarette? That's a "choice of *experience*" too...Camel!
I NOTICE MORE AND MORE PEOPLE SMOKING CAMELS. THEY'RE GREAT!
I LEARNED BY EXPERIENCE... BY COMPARING... THAT CAMELS SUIT MY 'T-ZONE' BEST!
THE "T-ZONE"
T for Taste...
T for Throat...
your final proving ground for any cigarette
R. J. Reynolds Tobacco Company, Winston-Salem, N. C.
Let your T-Zone tell you why
More people are smoking Camels than ever before!
● Now that people can get all the cigarettes they want ... any brand ... now that they once again can choose their cigarette on a basis of personal preference ... more people are smoking Camels than ever before.
Why? The answer is in your "T-Zone" (T for Taste and T for Throat). Let your taste ... your throat ... tell you why, with smokers who have tried and compared, Camels are the "choice of experience"!
CAMEL
TURKISH & DOMESTIC BLEND CIGARETTES
CHOICE QUALITY
According to a Nationwide survey:
MORE DOCTORS SMOKE CAMELS THAN ANY OTHER CIGARETTE
When 113,597 doctors from coast to coast were asked by three independent research organizations to name the cigarette they smoked, more doctors named Camel than any other brand!
CHOICE OF EXPERIENCE!

Contributors . . .

Alfred C. Ames is assistant professor of English at Illinois Tech. He received his bachelor's degree at the University of Kansas and his master's and doctorate at the University of Illinois. He taught at Illinois from 1937 until 1944, when he joined the staff of Illinois Tech. Dr. Ames' articles have been published in *Poetry, ETC.: A Review of General Semantics, Modern Language Notes,* and the *Journal of Engineering Education.* An earlier article by Dr. Ames, "English at Illinois Institute of Technology: A Unique Situation", appeared in the October, 1947, issue of the ILLINOIS TECH ENGINEER.

David Baker, a graduate of Illinois Institute of Technology, is architect for the electronics division, bureau of ships, Navy department. He received his B.S. degree at Illinois Tech in 1938. Awarded a graduated scholarship, he studied design under Professor Ludwig Mies van der Rohe in 1938 and 1939. He was presented the American Institute of Architects award for scholarship and the Charles L. Mutchinson medal for the highest record in architectural design, and he received the Kendall Graduate scholarship from Harvard university in 1941. He was awarded a master's degree at Harvard in 1942. Mr. Baker has been engaged in various capacities with leading architectural and engineering offices. He is the author of numerous articles on architecture and city planning and is an authority on shore electronics stations and other structures for the Navy department.

Jesse E. Hobson is now director of the Stanford University Research Institute. Until March 1 he was director of the Armour Research Foundation of Illinois Institute of Technology. A biographical sketch of Dr. Hobson appears in the March, 1948, issue of the ILLINOIS TECH ENGINEER.

(Please turn to page 4)

COVER PICTURE—A model of Illinois Tech's campus of tomorrow, designed by Ludwig Mies van der Rohe.

VOLUME 13 NUMBER 4 MAY, 1948

ILLINOIS TECH ENGINEER

In this issue

JAMES W. ARMSEY, *Editor*

THELMA L. COLEMAN, *Business Manager*

Associate Editors

THEODORE A. DAUM FREDERICK W. JAUCH

Student Staff

SHERWOOD BENSON R. ROBERT LYDEN
BERTRAM A. COLBERT MACK McCLURE
WILLIAM B. FURLONG FRANK R. VALVODA
AARON L. ZOLOT

Published October, December, March and May.
Subscription rates, $1.50 per year.
Editorial and Business Office, Illinois Institute of Technology,
3300 Federal St., Chicago 16, Illinois.

(Continued from page 3)

Frank M. MacFall, research engineer at Armour Research Foundation of Illinois Institute of Technology, has done considerable study and research on the problems of ramie. Before joining the staff of the Foundation in February, 1947, he spent two years with the department of agriculture in Havana, Cuba, working with soft and hard fibers. For two years prior to that he had been with the department's cotton ginning laboratories in Stoneville, Miss. He was graduated in Physics in 1929 at Butler university where he gained membership in Phi Kappa Phi, national scholastic honorary. Before joining the department of agriculture staff, he was sales and service manager for the General Electric X-Ray corporation, which was then located in Chicago

James F. Oates, Jr., prominent Chicago attorney and civic leader, received his A.B. degree at Princeton in 1921. In 1924 he was graduated from Northwestern law school with a J.D. degree. He is chairman of the board of the Peoples Gas Light and Coke company of Chicago, former chairman of the board of trustees and still a board member of George Williams college of Chicago, and vice president and trustee of Lake Forest academy, Lake Forest, Ill. Immediate past president of the Chicago Bar association, he is also a member of the Illinois and the American Bar associations.

Basava Sri Ramakrishna is at present working toward a doctorate in physics at Illinois Institute of Technology. Born in India 26 years ago, he received his bachelor's degree at M.R. College, Vizianagaram, India, in 1941 and his master's at Benares Hindu university in 1944. He was a lecturer in physics at various schools in his native country for 18 months. He arrived in the United States in December, 1945, and at Illinois Tech shortly after. He is also serving as a research assistant in fundamental mechanics research.

John F. White, dean of students at Illinois Institute of Technology, was graduated at Lawrence College *(Please turn to page 59)*

RAMIE— an Age-Old Problem

by **FRANK M. MacFALL***

THE production of ramie, an age-old fiber, presents problems which bid fair to tax the ingenuity of modern industrial research. Ramie, cultured and processed in China since time immemorial, has resisted successfully the efforts of individuals to mechanize its production. Will coordinated research be able to solve these problems and permit ramie to assume its rightful place in the textile industry? Ramie, indeed, presents an interesting challenge!

Ramie fiber, marketed under the trade names of "China Grass" or "Grass Linen," is obtained from the ramie plant (*Boehmeria nivea* L.) a member of the stingless nettle family. The ramie plant, a branched shrub, is a perennial which may be propogated either from seed or from root cuttings, the latter being preferable because seed plantings require starting in seed beds and later transplanting. A suitable soil is one which is moist but not sodden; a friable loam with porous subsoil is preferred. Plants should be spaced at least three feet apart to permit rapid growth. This plant manages best in a hot rainy climate such as is encountered in the tropical countries. Despite the frequency of harvest, the plant will regrow and thrive for many years without replanting. In tropical countries the plant grows to a satisfactory height of from four to six feet in approximately 60 days. It is reported that six crops a year can be harvested in the Philippines. The climate of Cuba permits only four crops a year, this frequency tapering off to a single annual crop in the temperate regions of Alabama and Georgia. Production-per-acre figures vary widely, but an acre will produce about four or five tons of green stems per cutting from which 500 to 750 pounds of dry clean fiber can be obtained. In localities, therefore, where three or four cuttings per year are made, a ton of dry clean fiber per acre can be anticipated each year.

In addition to the extensive cultivations of ramie in Western China and other parts of the Far East, ramie cultivation is practiced to a varying degree in the Philippines, Algiers, France, India, and Italy. In the western hemisphere plantings will be found in Brazil and Cuba. Cultivation in the United States is restricted to areas of Florida, Georgia, Alabama, Mississippi, Louisiana, and California.

The fibers yielded by the ramie stalk are contained in that part of the stem which lies between the outer bark or peel and the inner wooden core, where they are embedded in various gums and resins. The fibers are classed as bast type fibers inasmuch as they come from the stem of the plant rather than from the leaves or seed pod. The single ramie fiber is extremely fine in cross-section, varying from 30 to 70 microns, and averages from four to six inches in length. The ramie fiber is similar in cross-section to cotton, the contour varying from hexagonal to oval. Longitudinally, ramie appears as an irregular, knotty, ribbon-like fiber. The fiber contains many fissures or cracks which make it much weaker than would be theoretically expected. Here is a fertile field for the geneticist!

The fiber is unsurpassed among the natural fibers for length, strength, durability, color, and purity. When processed properly it is the most lustrous natural fiber known apart from silk. One authority states that ramie is four times stronger than hemp, eight times stronger than flax, twelve times stronger than cotton, and twenty-four times stronger than silk!

Most fiber plants of the bast type, such as hemp, flax, kenaf, etc., can be processed and the fiber removed by "retting." Retting consists of placing bundles of the stalks under water for a period of 10 days to two weeks, during which time bacterial action loosens the mass of the plant substance and dissolves the binding gums and resins, causing the fibers to separate from the stem material. Ramie, however, is not amenable to

* Research engineer at Armour Research Foundation of Illinois Institute of Technology.

this treatment, for the resins which bind the fiber in the plant are insoluble in water and are not susceptible to known bacterial actions. This inability to separate the ramie fiber from the plant stem by the known methods has been the major stumbling block in the development of the ramie industry.

Ramie fiber is adaptable for processing on present types of flax machinery. It can also be worked on waste silk machinery, or worsted cards, combers, and preparing frames.

The dried degummed fiber, as received at the mill, must be softened. This can be readily accomplished on the usual type of circular hemp softener.

After softening, if the material is too long it is cut or broken on an ordinary type circular diamond cutter, or hemp brake. The material can be cut in two, producing a root and top section, or the root and top ends can be cut off, leaving a long middle section. The latter method produces more waste material but furnishes the more choice middle section of the fiber. The method selected depends on the condition of the fiber and the use to which it will be put.

The fiber is then hackled or parallelized, drawn, and spun into yarn. The short fiber (tow) combed out in preparing the long fibers is processed separately into low-grade yarn.

The versatility and value of this fiber is shown by its many uses. It is used in the manufacture of upholstery fabrics, brocades, damasks, tapestries, linings, neckties, suitings, dress fabrics, furniture plush, frieze velvet, fire hose, dry batteries, lace, endless driving belts, machinery cloth, incandescent lamp mantles, sole shoe thread, fishing lines, net hosiery, sewing thread, scarves, handkerchiefs, table linen, and in the making of fine paper. The remarkable length of the ramie fiber makes it possible to spin ramie into yarns having 50,400 yards to the pound with minimum twist and maximum lustre.

The ramie plants above, at Santiago de las Vegas, Cuba, are 29-days old.

The history of ramie extends back as far as the early days of the Chinese and Egyptian dynasties, at which time it was used extensively in the manufacture of fine fabrics. The lasting and preservative qualities of ramie are well shown in the mummy wrappings found in the recently unearthed tombs. Ramie mummy, wrappings, centuries old, were found in an excellent state of preservation!

When one reads the story of ramie he is sharply reminded of the futile efforts of the ancient alchemists who sought to transmute metals. Throughout the centuries mankind has spent lifetimes of energy and fortunes in wealth in an attempt to solve the problems of ramie so that it might be produced economically in commercial quantities. In the 1870's the government of India offered a bonus of $25,000 for a process or machine capable of producing ramie fiber at a reasonable cost. This offer remained unclaimed and was finally withdrawn in 1881. Today, most of these problems are still unsolved!

While the rest of the world was trying to mechanize the production of ramie fiber, the Chinese continued to produce the fiber by hand labor. Their manual process, which is still in use in most parts of western China, produces only a few pounds of fiber a day. Since this process, even today, accounts for the greater share of the ramie fiber produced, Sir Alexander Horne's description of the process should prove interesting; mechanized efforts in many instances have been directed towards duplicating the hand process mechanically. Horne states, "At the ramie harvesting the workman seizes the ramie stem about nine inches above the ground between the thumb and the fingers of the right hand, snaps it over to the right, causing a fracture, pushes down and sideways the upper part of the stem on the fracture to complete the divi-

(Please turn to page 22)

Alumni Support of Colleges

by JAMES F. OATES, JR.*

Editor's note: The following article was delivered by Mr. Oates as the main address at the Kick-Off dinner for the 1948 Illinois Tech alumni fund drive. The dinner was held at the Chicago Bar Association April 9.

James F. Oates, Jr.

I APPEAR before you tonight as a metaphysician. Don't be alarmed —this sounds much more formidable than it is. Recently I was exposed to Dr. Robert Maynard Hutchins in a great books course and there learned the real meaning of the word "metaphysician." It appears that none other than Mr. Aristotle himself has made clear that the one foundation of metaphysics is the so-called law of contradiction. You will remember that the law of contradiction is simply the rule that what exists cannot exist at the same time. This seems to be self-evident, but curiously enough, the law of contradiction is difficult to demonstrate. Indeed, Aristotle is quoted as saying that any one who attempts to demonstrate the law of contradiction is a vegetable. Actually, the only way it can be proved is by inducing some one else to disprove it. You see, when another person says that the law of contradiction is unsound, he is affirming a position and thereby implicitly denying the nonexistence of the position affirmed, and you have won the argument negatively.

All of which means, if it means anything, that every one is either a metaphysician or reduced to silence, and since I could not be reduced to silence when asked to speak on the subject of alumni support for Illinois Institute of Technology, I claim to be a metaphysician.

Let us review a few basic concepts to serve as a backdrop for our discussion. We face in this country today perhaps the greatest crisis in the history of our democratic Christian tradition. This is so seriously true that it sounds trite. Throughout the world, the sphere of government continues to encroach more and more on the daily life of the individual man. The United States of America is not immune from this process.

There are, of course, various conflicting theories of the proper field of government, most of which, on ultimate analysis, resolve themselves into two general categories — the first where the sphere of government is imposed on the people, necessarily involving tyranny in some degree and a corresponding loss of freedom by the individual citizens; the other that the sphere of government in the life of man is not a matter of coercion, but of grant from the people. For the several years last past, this general controversy has been debated and indeed pulverized. The disagreement is now magnified in the lens of the out-reaching ideology of communist Russia.

An idea, even the brutal idea of dictatorship, cannot be destroyed with force. It must in the long run be overcome and submerged by a more acceptable and sounder idea. Ideas which do not work and bring satisfaction are not acceptable. It is, therefore, of primary importance that the democratic idea of freedom should operate effectively, in order that it can be recognized around the world as more acceptable than the tyranny of any form of statism.

We have been told that throughout the history of the world, democratic forms of government have repeatedly failed and some form of Statism has arisen whenever the economic and social problems of society become so complex and general that they require collective action for solution. We now face the significant and searching question— are the problems of modern society so broad, so complex, and so imperatively important that they cannot be solved without the impairment or possible destruction of the liberty of the individual? Of course, unless liberty exists for the individual, it does not exist at all.

It is submitted that the one best chance the democratic Christian tradition has for survival against the impelling urge of collectiveism rests upon the strength of the church and upon the maintenance and development of independent private educational institutions.

If the churches are open and the

* Prominent Chicago attorney and civic leader.

independent colleges are free to pursue truth, democracy will work. This is clearly recognized in the foreword written by President Heald in the booklet describing Technology Center — "Today and Tomorrow" — when he says: "We at the Institute believe that institutions such as ours must be maintained and strengthened as independent centers of education and scientific inquiry — particularly in this era of greater centralized control. Illinois Tech's plans for the future are based upon continued growth and increased service through independent action—a free partnership of science, industry and education."

We, therefore, confidently assert that the privately supported educational institution at the college level is in the first line as a great bulwark of democracy.

In a democratic and free society, all of the facts should be available to provide the only sound position upon which any action may safely rest. Indeed, only in a free society can all of the facts be made available. Judgment on any problem is no better than the facts upon which it is based. It is in the colleges and universities that men and women are trained to acquire all facts, to appraise them on the basis of the criteria of value which constitutes the ethical, cultural and religious heritage of the race, and then, and only then, act.

The necessity of free access to all available data and free scope in evaluating such data is axiomatic in the field of technological progress. It seems clear that no scientific research worthy of the name could possibly be maintained successfully while subject to significant limitations upon access to facts and upon criteria to evaluate data. While public educational institutions are of the greatest importance, indeed they can be the very flower of modern civilization, they also need the private and independent sister institutions. It is a fact that Illinois Institute of Technology cannot exist as we know it, except as an independent and free institution.

I was interested in hearing Dr. Wilson, chairman of the Standard Oil Company of Indiana, state at a meeting the other day that no government could efficiently operate the oil industry for the simple reason that no political leadership could afford to risk the consequence of a production record involving a large percentage of dry holes. In 1947 the oil industry average for so-called wildcat wells was 80 percent dry holes; for Standard Oil of Indiana the comparable record was 70 percent. He added that while the oil resources of Russia were enormous, the fields would never be adequately drilled because the commissars would never risk the consequences of inevitable failure in petroleum exploration. Scientific research is dependent, in large measure, upon the empiric process which, by definition, involves a large percentage of failure as the very foundation of ultimate success. Surely progress in science is dependent upon the initiative, freedom, and venturous spirit characteristic of the privately supported independent institutions.

The Chicago community—indeed the nation—owes much to Illinois Tech. The contributions made by the individual graduates and by Illinois Tech's research activities are too well known to describe in detail, but they are certainly most impressive, as you well know far better than I.

In glancing through the 1947 Annual Report of Armour Research Foundation, entitled "Partners in Research", the reader is absorbed in, and fascinated by, the catholicity of interest and accomplishment. There we find, among many things, an ac-

(Please turn to page 26)

Two-hundred-fifty Illinois Tech alumni gathered at the Chicago Bar Association April 9 to hear James F. Oates, Jr., deliver the main address at the Kick-Off dinner for the 1948 alumni fund. Mr. Oates is seated to the right of John P. Sanger, general fund chairman, who is at the microphone.

Extracurricular Activities at ILLINOIS TECH

"THE first goal in education for democracy is the full, rounded, and continued development of the person".[1]

Educators and personnel men have struggled for years with this problem of developing in our colleges and universities what have come to be known as "well-rounded men and women". Too many have sought to achieve this end through the classroom alone, and far too few have seen and taken advantage of the opportunities afforded by a well-coordinated and well-stimulated program of outside activities. In considering the question, it behooves us first to define the term, "well-rounded man and woman".

He or she is a person who has been educated to the point where it is possible, on the basis of this instruction, to earn a livelihood and to make a useful contribution to society through the practice of a chosen vocation; but, as important or more important, he or she is also a person who is able to, and does, assume in an intelligent manner a rightful responsibility as a citizen and who spends leisure time in healthy and useful activity. Any extracurricular program, any curriculum, any college, which does not have this as its ultimate goal has failed in its responsibility.

* Dean of students at Illinois Institute of Technology.

[1] Report of President's Commission on Higher Education: *Higher Education for American Democracy*, Vol. 1, pp. 9: U. S. Gov't Printing Office.

In planning a balanced college program, we cannot overlook the importance of the extracurricular phase.

Members of the staff of *Technology News*, student weekly newspaper at Illinois Tech, work on make-up for the coming issue. Unlike those of most college papers, the staff of *Technology News* is generally composed of persons who find journalism an interesting sidelight rather than a prospective vocation.

It is here that the student will have an opportunity to take part and lead his fellow men in activities from which he will derive experience and interests useful to him for the rest of his life. No longer can activities of this type be permitted to exist simply because they provide a channel for the student to "let off steam". Like any course in the curriculum, any club or other activity must pass the test of usefulness — does it make a contribution to the development of the individual? If it does, the college should support and, if necessary, nourish it; if it does not, it has no more real use than a course in the "Love Life of the Mosquito". Obviously, if we found such a course in our college, we would get rid of it; the same should be true of a useless activity.

Industry has for some time recognized the importance of extracurricular activity. Those charged with responsibility for hiring young college graduates are always looking for the young man with good grades *and* leadership ability as evidenced by participation in activities. Industry generally prefers that man to the one with higher grades but no record of such participation.

There are obvious difficulties in reaching a balance between course work and outside activity, especially in an engineering college of Illinois Tech's type. In the first place, engi-

by JOHN F. WHITE*

Illinois Tech cheer leaders lead their fellow students in a yell that they hope will fire their Techawks to a basketball victory.

neering curricula are noted for the extremely heavy academic program they impose upon students. The long hours in laboratories, classrooms, and shops are a constant source of "gripes". Then, too, Illinois Institute of Technology's location in a large municipality further complicates the situation. It has no choice but to become a "street-car college" where students are inclined to check in at 8 a. m. and out at 5 p. m., with little or no time or effort for anything but the required course work. We are making a continuous effort to overcome these difficulties, but the problem is such that improvement cannot yet be measured.

Illinois Tech makes this effort because participation in proper student activities relieves the strain of the tedious job every college student faces; because it develops confidence and leadership in the individual, permits self-expression, and provides an opportunity for the student to meet a greater number of people; and because it creates new interests for the student and, even more important, helps to develop a healthy attitude in the student toward the world and the profession he has chosen.

In planning such a program, one must include organizations of at least six types:

(1). There are, first, the civic and service groups. If, at the college level, we fail to develop in the student an interest in serving his fellow men, we will surely fail in our efforts to give him an "education for a fuller realization of democracy in every phase of living".[2]

(2). A second activity is that of the professional type, which takes two forms—departmental organizations and honorary societies for those men who have excelled in their studies.

(3). One cannot overlook the need for recreational activity, which takes form in athletics and hobby clubs. Athletics are too often thought of as varsity athletics alone. The college program must include much more than this; programs of physical training, hygiene, and intramural competition are important.

(4). Fraternal and other closely knit groups, whose memberships depend upon selection and whose direction is determined by personal interest, are also necessary and significant.

(5). Religious activities must be included in any well coordinated program.

(6). A sixth category will include groups devoted to special interests such as music, drama, and literature, nationality groups, and others which crop out in any normal community of 3,000 people.

Illinois Institute of Technology recognizes its responsibility in stimulating and aiding these extracurricula groups. It has sought to meet that responsibility by providing the direction for such activity and by making available certain services. Organizations seeking a place on its campus are screened by the proper authorities and if found acceptable are approved and supported. All such groups are approved if they show promise of making a contribution not already being made to the life of the individual student. (At the present time, there are 78 different active

[2] Ibid., p. 8.

The Musical Clubs of Illinois Tech perform at numerous school functions, have given concerts at the Civic Theatre, and make frequent trips to neighboring communities in the Chicago area. Under the direction of O. Gordon Erickson, the clubs are composed of orchestra, band, and glee club. The orchestra and glee club are shown in the picture above.

organizations on the campus).

Like the ideal curriculum, the ideal extracurricular program must provide for individual differences and interests; consequently, it must include a variety of activities. *But its heart and nerve center lie in a vital and successful student government.*

At Illinois Tech, student government rests with the Illinois Tech Student Association. Its Board of Control, operating on an annual budget of more than $20,000, coordinates student activities and allocates funds to those organized on an all-college basis.

One of its main functions is to provide the funds necessary to support the journalistic efforts of the students. The student newspaper, the yearbook, and the student handbook—all notable for their excellence—provide a real opportunity for experience and service for the young men and women on their staffs.

Opportunities to serve the campus and community are provided through the traditional Junior Week and Open House, the Forum Club, the Assembly Committee, the Community Service group, the Student Admissions Advisory Council and Alpha Phi Omega.

The last-named, a fraternity organized as a service group, is composed of college students who formerly served as Boy Scouts. This particular organization serves as a welcoming committee and guide for all incoming freshmen classes and thereby assists the college in orienting new students. It also assumes responsibility for the annual March of Dimes Campaign, ushers at campus affairs, and currently is planning to publish a faculty-staff-student directory.

The Community Service Club is composed of a number of students interested in the development of better relations between the college and its neighborhood. These young men and women have sought to develop a recreation program for the neighborhood children. While their program has suffered several setbacks, the fact that Illinois Tech students are interested in and will work toward such an objective is to their credit.

In these civic and service groups, the attitudes mentioned earlier are fostered and developed. For the most part, such activities are centered in campus life, but that campus life makes up a community within itself and serves as a laboratory for later life.

Construction of the new gymnasium last fall has been a significant stride in the development of recreational activity for students at the Institute. This building provides adequate locker rooms, showers, workout rooms, and two full-sized basketball courts. This makes it possible for large numbers of the students to participate in competitive and recreational activities previously denied them. Any time between 8 a. m. and 10 p. m. on any school day, visitors will see students playing basketball, volley ball, or badminton, or taking part in boxing or wrestling matches.

This new facility required a new member of the Institute staff, who was charged with the responsibility of encouraging, organizing, and supervising the intramural program. Swimming, basketball, touch football, ping-pong, bowling, track, boxing, and wrestling are now regular and popular activities on the campus. These are all in addition to the regular physical education course required of freshmen. Other recreational or hobby clubs, such as the Photography Club, the Chess Club,

(Please turn to page 30)

The Future of Materialism

by B. S. RAMAKRISHNA*

MATERIALISM, like other great philosophies of the west, was born of a set of scientific beliefs that were held widely among men of science over a fairly long period from the time of Newton. It is therefore to be expected that the history of materialism should be influenced largely by the progress of science.

The success with which a large number of natural phenomena were explained by the laws of Newton gave an impetus to seek a mechanical interpretation to all the observable phenomena of the material universe. The belief in the possibility of such an explanation was reinforced by the ever increasing successes which the science of mechanics achieved in the hands of the later mathematicians, such as Lagrange, Laplace and others in the eighteenth century. Until the close of the eighteenth century, mechanics was largely concerned with the study of the macroscopic states of matter; but the beginning of the nineteenth century placed the atomic nature of matter on a solid basis, and mechanics was faced with the new problem of applying the principles which explained astronomical phenomena with surprising success to the microscopic and invisible world.

Maxwell, Boltzmann and other physicists of the age showed that the well-known properties of gases such as pressure, temperature, etc., could be given a very simple and convincing explanation on the hypothesis that the atoms or the molecules composing the gas are in rapid incessant motion, colliding, as they move, against one another and with the walls of the container. This theory—well known in science as the Kinetic Theory of Matter—scored triumph after triumph in the predictions it had made, and the new light it had thrown on the behavior of matter. For a time no doubt was left in the minds of the 19th century scientists that the goal of physical science lay in the ultimate explanation of the universe by mechanical principles.

It was maintained that if we know the position, velocity and forces acting on every particle or atom in the universe at any time, we could completely determine the state of the universe at any subsequent time. This did not mean that we could actually carry out the calculation, but the latter was merely a question of the labor involved. It did, however, imply an important consequence, viz., that the course of the universe is predetermined, and leaves no scope for the human mind to alter the destiny of the universe. Thus, the philsophy of mechanistic predetermination developed entirely in opposition to the doctrine of the freedom of will.

The first half of the nineteenth century, which saw the beginning and the growth of the atomic theory, also witnessed a similar trend in the development of chemistry and biology. For a long time it appeared that certain chemical compounds which were found abundantly in the animal kingdom resisted all attempts at their synthetic preparation. It was therefore held that the presence of living matter is in some way essential to the formation of these compounds, and that, although living and non-living matter is composed of the same elements, there is an essential difference between the organic and the inorganic world.

The first shattering blow to this belief was delivered when Wohler, in 1827, prepared synthetically the compound Urea, hither-to known to exist only in the organic world. Then followed a period of rapid development of the synthetic preparation of the various compounds, and the gulf between the organic and the inorganic world seemed to diminish rapidly.

These two theories, viz., that there is no difference between living and non-living matter and that the future history of every atom in the universe is predetermined—although far beyond human calculation—seemed to lead to one very important conclusion.

Stated in the plainest terms, that conclusion amounts to this: that if the position, velocity, etc. of all the atoms that constitute the human body are known at any instant, the future behavior of the individual can be determined, at least in theory. This implies a negation of the power of the mind to control the destiny of the body.

It is interesting to digress a little at this stage and examine the various reactionary philosophies that developed in opposition to the materialist philosophy. The idealist philosophy, which reached perfection in the hands of Bishop Berkeley, is the exact counter-part of ma-

(Please turn to page 38)

* Graduate student and research assistant at Illinois Institute of Technology.

TRENDS in Industrial Research—II*

by JESSE E. HOBSON†

Public Service Research Organizations

SEVERAL types of organizations have been established to render a service of scientific and engineering research to industry and government on a fee basis. These organizations include the consulting laboratories of such firms as Arthur D. Little, Carl Miner, Foster D. Snell, and others; engineering research and development laboratories such as Barnes and Reinecke, Buehler and Company, Mast Engineering Company, Engineering Research Associates, etc.; and the non-profit research foundations and institutes such as Franklin Institute, Mellon Institute of Industrial Research, Battelle Memorial Institute, Armour Research Foundation of Illinois Institute of Technology, Midwest Research Institute, Southern Research Institute, and others. Some of the latter institutes have a more-or-less close affiliation with an educational institution.

It is of interest to survey the activities of the leading non-profit research institutes since they reflect the diversity of scientific activity undertaken by government and industry, because they work simultaneously in several industrial and scientific fields, and because their growth and activity roughly parallels that of all industrial research in the United States. Further, these institutions form a unique pattern of research organization which is being copied throughout the world. The primary objective of such institutions is to render a confidential research and engineering service to industry and government on a cost basis. They have, however, important secondary functions of promoting and furthering fundamental research and of supplying men, trained in the approach and techniques of applied research, to the laboratories of industry and government.

The non-profit research institutes do not intend to compete with existing commercial laboratories, testing laboratories, or consulting engineering firms since they are established on a basis of tax exemption. They make every effort to accept projects which do not compete with research services available elsewhere. Projects are accepted on a confidential basis, with full patent and publication protection given to the sponsor.

The Battelle Memorial Institute, Columbus, Ohio, is a non-profit privately endowed institution founded in 1929 by a bequest from Gordon Battelle. Income from the bequest has been used to provide buildings and equipment and to support an active program of fundamental research. The volume of industrial and scientific research conducted at Battelle in the calendar year 1947 will amount to approximately \$4,250,000, an increase of 24 per cent over the volume for 1946 which amounted to \$3,425,000. The research activities cover diverse fields. A rough diversion of this activity in broad fields during the first six months of 1947 was:

Metallurgy	25%
Chemistry	20%
Physics	17%
Fuels Technology	12%
Ceramics	6%
Mineral Processing	4%
Welding	4%
Production Research	4%
Graphic Arts	4%

* This article and the preceding one by Dr. Hobson in the March issue of the *Illinois Tech Engineer* will appear in the forthcoming *International Industry Yearbook*, edited by Lloyd Hughlett and published by McGraw-Hill International company.

† Director of the Stanford university Research Institute; formerly director of Armour Research Foundation of Illinois Institute of Technology.

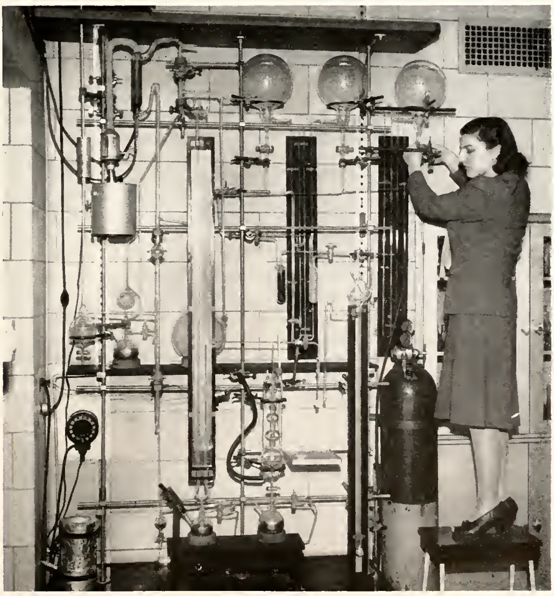
Miscellaneous 4%

More than 250 investigations were in progress during the year, 60 per cent of which were for industrial sponsors and 40 per cent under sponsorship of government agencies. The staff of the Institute numbered 860 on January 1, 1947. By December 1, 1947 the staff had grown to 1,028, of which 60% are trained scientists, engineers, and technicians, and 40% are administrative and service personnel.

The Mellon Institute of Industrial Research is the outgrowth of a plan originally conceived in 1906 by Dr. Robert Kennedy Duncan. The fellowship system was designed to provide scientific research facilities and personnel for public use. Evolved to give manufacturers the privilege of establishing a temporary fellowship in a university for the investigation of a particular problem, it was expected that the solution would benefit the manufacturer and ultimately the public.

In 1910, Andrew W. Mellon and Richard B. Mellon asked Dr. Duncan to put his plan into active operation at the University of Pittsburgh. Fostered by the generous Mellon endowment, the plan was successful and was placed on a permanent basis in 1913. Until 1927 the Institute remained a part of the University of Pittsburgh, at which time it was separately incorporated. Since then it has been managed by an executive staff responsible through the director to its own board of trustees. The Institute cooperates with the University of Pittsburgh, and members of its staff may take graduate work in the university. However, the "fellows" in Mellon Institute have the status of salaried workers.

During the fiscal year ending



The picture at the right and above shows an experimental combustor used by a fuel technologist at Battelle Institute in a study to develop a pulverized-coal-fired combustion chamber for gas-turbine-driven locomotives. The picture below, taken at Mellon Institute, shows apparatus used for research on absorption.

This is a general view of the extensive machine and carpentry shops at Midwest Research Institute.

March 1. 1947, the expenditures for pure and applied research at Mellon Institute totalled $2,697,982. The staff consisted of 295 Fellows and their 280 aids, 34 more Fellows and 16 more aids than in the preceding year.

The Institute was active on 80 industrially sponsored projects, of which 6 have been in progress for 30 years or more, 2 for 25 years or more, 9 for 15 years, and 19 for 10 years. It conducts research in the fields of pure chemistry and in chemical physics. The Industrial Hygiene foundation, a non-profit national association for advancing health in technology, operates under the Institute's auspices.

Armour Research Foundation of Illinois Institute of Technology, located in Chicago, was founded in 1936 without endowment. It is a separate corporation although it reports to the president and the board of trustees of Illinois Institute of Technology. Since its conception. Armour has been an entirely self-supporting organization, maintaining its own staff and facilities.

During the fiscal year ending August 31, 1947. the volume of sponsored research for industry and government at Armour Research Foundation amounted to $2,551,854, an increase of 34.6% over the previous fiscal year. Of the 105 active research projects on September 1, 1947, 39 were projects under government sponsorship and 66 were sponsored by industry.

The Foundation is organized in three operating divisions:

1. The Research Division
2. The Magnetic Recording Division
3. International Research Division

The latter division, recently organized to render a research service to foreign governments and industries in foreign countries, has its headquarters in Mexico City.

The Research Division has departments of physics, chemistry and chemical engineering, metals, ceramics and minerals, electrical engineering, applied mechanics, mechanical engineering and research services.

On September 1, 1947 the staff of Armour Research Foundation numbered 488. with 322 on the technical staff and 166 on the service staff. A further analysis of the 322 members of the technical staff shows that 12.5% were occupied with scientific and technical supervision, 59% were research scientists and engineers, and 28.5% were classified as technical and scientific assistants.

Midwest Research Institute in Kansas City was organized early in 1945 and recently completed its third year of operation as a non-profit independent, research institution serving both industry and government. In addition to functioning as a research institute serving the industries of the United States, the Institute has a unique function as a regional research laboratory working toward the development of the natural resources of the central midwestern states. Although an independent organization, Midwest cooperates with educational and research groups, particularly in the region from the Mississippi river to the Rocky Mountains. Conducting

(Please turn to page 46)

TECHNICAL WORDS

by ALFRED C. AMES*

THE specialized vocabularies of science and technology are rich ore for students of the history of either language or science. Language, our indispensable daily instrument, our principal means of expression and communication, is full of unrecognized vestiges of the diverse processes of cultural history.

Indeed, every single word has a history of its own. Every word in English entered the language either in Germanic antiquity or from some foreign tongue within historic time. To study the migrations of word roots is to be awed by the internationalism of our knowledge. Our debt to Greek and Latin becomes apparent, and to other tongues as well. We are reminded of the contributions to science of individual men whose names have become common nouns. The dimension of time is evident to the student of words. It becomes possible, through specific, detailed study of the earliest recorded dates for the appearance of technical terms, to perceive the bloom periods and sometimes the amazing youth of specialized vocabularies, and to compare the life cycle of one branch of science with that of another. New uses of old words bring many surprises. Many obscure facts and unrecognized metaphors are to be discovered in etymologies. In short, the study of the history of technical language carries one far into the history of science, and into awareness of the cosmopolitanism of technology.

The *New English Dictionary on Historical Principles* endeavors to exhibit the full life history, so far as it is known, of every word found in English since about 1000. Preparation of this greatest of all dictionaries occupied scores of workers over decades. Publication of sections extended from 1884 to 1928. A fat supplement appeared in 1933. About a quarter of a million main words are treated in this sixteen thousand page work, which is the major source for study of the development of the English vocabulary between 1000 and 1930. Using this mammoth dictionary as a source, sixteen students at Illinois Institute of Technology recently investigated selected segments of technical vocabularies in fields of their especial interests. What follows is a selection and synthesis of materials assembled by the industry and ingenuity of these students of the English language.[1]

In English, function words and many of the words for the most universally experienced objects, relationships, and concepts are of Germanic origin, with a history in English that goes back well beyond 1000. Modern English is a West Germanic language, lineally descended from the tongues of Angles, Saxons, and Jutes, whose invasions of Britain began in 449. But even before these Teutons left the continent, their language had absorbed numerous loan words from Latin. Though the Roman Empire fell, the hegemony of Latin in the intellectual life of Europe was unbroken until modern times. In the formation of technical vocabularies in English, classical influence has been dominant.

Mathematics is a case in point. A vast majority of mathematical terms go back to Latin, many of them by way of Old French. Some words retain their Latin spellings—*area, calculus, integer, locus, modulus, radius.* Others have spellings first acquired in French—*addition, arc, degree, function.* Some are Latin forms minus inflectional endings: *circumscribe, decimal, determinant, product, sum.* Second only to Latin is the Greek influence. From Greek come such familiar words as *cube, cylinder, geometry, ellipse,* and *sphere,* and such esoteric ones as *adiabatic* and *loxodromic.* Traces of the Arabic contribution to mathematics are found in *algebra* and *azimuth.* The native Teutonic element is slight, being confined to words bearing non-technical meanings also, such as *length* and *root.*

Chemistry, likewise, speaks in classical tongues, though here there is almost a balance between Latin and Greek. (The date of word-formation, as we shall see, helps account for the large Greek element.) Representative words of Latin stock include *acid, affinity, carbon, detergent, emulsion, occlusion, polarization, precipitate,* and many more highly technical terms, such as *acetic, butyl, collinate,* and *furfurine.* Familiar Greek descendants include *aromatic, crystal, dynamite,* and *glycerine. Allotropy, anisotropic, endothermic, meniscus,* and *plasmolysis* remain meaningful only to Greeks and chemists. From exotic sources and distant times come *alcohol* (of Arabian and Hebrew sources, with the original referent a cosmetic powder for stain-

(Please turn to page 56)

* Assistant professor of English at Illinois Institute of Technology.

[1] These students, and the fields in which they worked, are: Robert B. Bell, photography; William M. Boyer, organic chemistry; Donald Chiz, organic chemistry; Frank M. Fisher, surveying; Julian Friedman, mathematics; Robert W. Hitzeman, law; Henry J. Job, mechanical engineering; William Kanoff, physics; Jonas A. Korn, physical and inorganic chemistry; Joseph C. Kowalski, metallurgical engineering; John Leck, electrical engineering; Frank Mannella, music; Orlando Mannella, music; Martin C. Mazurk, meteorology; William J. Parks, electrical engineering; and F. J. Ryan, mechanical engineering.

ARCHITECTU

For

NAV

by **DAVID BAKER***

WISHING to set the best possible example in its post-war construction, the Electronics Division of the Navy Department, in cooperation with the Bureau of Yards and Docks, has attempted to evolve a basic layout for the United States Naval Radio Transmitting Station, Dixon, Calif., which will function with a minimum number of personnel, provide low maintenance cost, and solve all probable expansions in the future.

This radio transmitting station is located approximately midway between San Francisco and Sacramento and is in an area subject to earthquakes. Ample radio station supporting facilities are included at the site. Among these are an emergency power building, utility buildings, quarters, garage, and other units that go to make up a self-contained group.

The radio transmitter building is designed to function as a basic unit capable of expanding in terms of transmitter room increments. The transmitter room layout is determined by the quantity of equipment as well as the limitations of control imposed by the use of a single person.

The building expresses a definite architectural character rather than a box-like interpretation, by the location on the outside of the exterior wall, on centers of 13′ 4″ by 40′ 0″, the columns which support the roof loads. This provides for a clear wall surface on the interior of the building and allows for ease of cleaning and lowered maintenance cost. It provides unobstructed maximum working area around the transmitters, and makes possible the running of transmission lines without any obstructions whatsoever within the transmitting room.

In order to obtain a flexible arrangement for routing incoming transmission lines to the various transmitters, seventy-five pairs of entering insulators are located beneath the protecting cornice of the building. Thus, an incoming transmission line is pulled tight and held fast on the transmission line anchor and looped under the cornice and into the feed through insulator.

A view of the interior of the transmitter building, United States Naval Communications station, Dixon, Calif., showing trench construction.

Trenches are used for cable, conduit, bus bars, piping, and the like, in lieu of an alternate design which would have made it necessary that the transmission room be on a second floor, with access to the cables which would be arranged in continuous hangers from the ceiling below. Low cost in installing cable is made possible by the ease with which cable can be rolled off the reels over the main trenches without moving any equipment to do so, as the equipment is installed directly over the adjacent system of small feeder trenches.

The finish floor material is terrazzo, ground smooth and divided into squares. The brass strips ordinarily used for dividing terrazzo could prove electrically dangerous to the personnel in the transmitter room, so plastic strips are used instead. Rather than a painted concrete surface, battleship linoleum, or asphalt tile, terrazzo fully meets the need of a good wearing surface capable of resisting heavy loads, and is easily maintained and kept clean. Trucks for carrying equipment for the initial installation or any emergency find easy access through the large aluminum sliding end doors and protection from the weather. An overhead rail for supporting a hoist is utilized over the end bays of the transmitter room. Thus, equipment is lifted from the truck by means of the hoist to a hand-steered electric powered trans-

* Architect for the electronics division, bureau of ships, Navy department.

west

OMMUNICATIONS STATION

A view of the entrance of the transmitter building.

porter. The use of the electric transporter permits a great deal of flexibility in placing the equipment on any desired location.

This windowless building, save for the administrative portion and the lavatory, is ideal for air conditioning. In addition, it keeps the building bug proof, a vital consideration, for bugs have a tendency to work their way into and damage the transmitter equipment. The windowless wall acts as a blast resisting surface and provides a good light reflecting surface for artificial illumination, because natural light would not be adequate for lighting the transmitter panels.

The air conditioning system is described as follows: For more than half the year, cooling of the transmitters and the building is accomplished by the introduction of cool outside air into the system to maintain a constant supply of 70 to 75 degree air in the supply ducts. This air is supplied to the administrative wing, the Communication Control Link room, the shop, and the equipment storage room. The air is 90% re-circulated or 100% exhausted through vents in the roof, depending on outside temperatures. When outside temperatures become such that 70 to 75 degree air can no longer be delivered, the refrigeration plant operates to supply the additional cooling required. The design is predicated to a 95-degree maximum room temperature in the transmitter room, which would occur only at the assumed maximum operating level.

In the normal course of operation, sufficient heat is generated by the transmitters to heat the building. This warm air is therefore recirculated and utilized for heating, being tempered by cool fresh air, introduced and controlled in the same manner as in the cooling cycle. Thus, the air in the ducts is maintained at a constant 70 to 75 degrees in the summer and winter. In the event of a shutdown, a boiler is provided as an auxiliary source of heat. Controls provide for the automatic operation of the system.

The duct system is designed to distribute air through overhead ducts except in the transmitter room. The main supply duct to the transmitter room is located under the corridor and console cable trench, and the feeder ducts in the transmitter room are located between the cable trench and the exterior walls. Auxiliary electric heaters are provided in the administration room and in the conference or mess room in the event of shutdown.

Designed for construction when future commitments so require is the VHF (Very High Frequency) tower which will be located on center over the loading platform. The cantilever floor of the tower provides for 360-degree area for spacing line of sight link antennae. The antennae will be of the parabolic reflector type.

Also planned for near future construction is the Standby Power building, designed in harmony with the Transmitter building. It is planned to house a single diesel unit with provision for another unit to provide

The interior of the transmitter room of the transmitter building.

power for the first building and the additional first expansion transmitter room increment. This arrangement permits all of the equipment to be under the surveillance of one man should the failure of the normal source of power occur. Space which is allotted for the future installation of an additional diesel driven generator can meanwhile be used to advantage for the storage of antennae and rigging gear.

Indoor antennae switching gear is contemplated. It will be divided into two units, each unit to be mounted overhead in the middle bay of each extending wing of the transmitter room and on center of the two rows of transmitters.

Switching will be accomplished by a system of handwheel switches and may possibly be remotely controlled at a later date. The completed unit will be suspended from cross members framed into side wall angles or channels in lieu of suspending the units from the ceiling or concrete girders.

The administrative unit is planned so that no enlargement is required in the event of expansion. The ever essential small kitchen finds a place in this area, inasmuch as coffee is a byword among the radio watchstanders; also, the isolated location of the radio station invariably makes it necessary that some meals be prepared in the station. The office and conference rooms have three-way exposure in order that the approaches to the station may readily be observed. The entry is preceded by a covered area to protect it from the weather. The ceiling of this portion of the building is acoustically treated.

For general unloading, the easily accessible rear platform is used. The CCL room houses equipment by which all transmitters are radio controlled from a remote location. The cleaning gear, lavatory and air conditioning units have been placed so that they provide the most economical runs of piping, cables, duct work, and control between the transmitter room of the first building and the first expansion increment.

The antenna arrangement consists of a number of Rhombic type transmitting antennae erected circularly from the transmitter building. The Rhombic system is utilized because of its directional characteristics. The antennae are oriented in the specific direction in which the maximum signal is desired. The transmission lines run directly from antennae to the antennae switching system in order that any transmitter can be connected to any transmission line. The transmission lines are the standard 600-ohm impedance open wire type. The transmission line anchors from an integral part of the building cornice design and, together with the antenna feed through insulator, it gives the radio transmitting station its definite character.

All concrete reinforcing steel is interconnected by welded joints and bonding wires to provide a continuous metallic electrical path to the ground rod. In like manner, all conduit equipment, metal doors, and metal window frames are carefully grounded.

Review of Navy experience on some of the radio transmitter reinforced concrete building types which were built in previous years, has disclosed that within a few months of operation the walls and roof of such structures heated up, cracked and flaked.

The partial disintegration of these buildings came about by the action of the reinforcing steel as it heated up and expanded at a greater rate than the adjacent concrete. This heating was produced in the steel rods by the standing waves acting on them; this was a result of the radio frequency energy given off by the transmitters, transmission lines, et cetera. By acting as ungrounded antennae, the reinforcing rods absorbed a detectable quantity of the radio frequency output.

In reinforced concrete transmitter buildings with exceptionally high power output, it has been found that the addition of a separate grounding and shielding system of copper rods, set in front of the steel rod reinforcing and held in place by the concrete envelope, proved satisfactory in carrying the radio frequency energy directly to ground and shielding the steel reinforcing from the radio frequency.

In planning the new United States Naval Radio Transmitting Station for Dixon, the fundamental characteristics of electrical effects have been taken into consideration in the design of the structural elements of the building.

An antenna acts as a conductor as it picks up radio frequency energy if it is a resonant component of the cycle of wave length, the range of which includes multiples as follows:
(Please turn to page 60)

RAMIE—an Age-Old Problem . . .

(Continued from page 7)

sion of the wood, inserts the forefinger of the right hand in the fracture which is now compound, and draws it up between the peel on the left and the wood and the adhering peel on the right, removing on its way branchlets, leaves, and tips. He then draws down the peel on the left with his left hand to the root, where it is readily detached. In like manner, the peel and the wood on the right are removed; the latter, which is loosely attached, can be readily separated from the peel.

"The operation is simple and can be accomplished with great rapidity. The Chinese then scrape gum from the fiber in the following manner: a piece of bamboo one-half inch thick, two and three-eighth inches long, and five-eighth inch broad, is grooved in the middle of the two one-half inch sides, and an arched band of copper or iron, three-eighth inches wide at the top of the arch and widening to one and five-eighth inches at the bottom, is hammered into the grooves. This forms a ring, which is put by the harvest man in the thumb of his right hand, the metal on the top and the flat piece of bamboo on the underside of the thumb. The other instrument is just like an iron shoehorn. It is seven inches long by two and one-half inches wide across the broad concave end, contracting to three-fourth inch at the narrow end with a very short thin tube through which a string may be passed when not in use for the purpose of suspension. The edges are blunt. The right hand also grasps the other instrument, concave side uppermost, by the thin end, leaving the thumb free. The flat bamboo can now be placed on the inner edge of the shoe horn and the ribbons of ramie peel are passed between them, outer layers uppermost, touching the piece of bamboo. At the harvest the peel is made into bundles and placed in a tube of cold water to steep for as short a time as possible and never for more than six hours.

"When the fiber is to be extracted, a bundle of peel is removed from the tub, unfolded, untied, and hung, the outer layer under, over a piece of wood raised above the ground to the level of the workman's breast. Taking a firm hold of the ribbons, one at a time, by the butt end with his left hand, the peeler seizes it about six inches from the butt between the thumb ring, bamboo, and the edge of the shoe horn, and scrapes it rapidly from the butt to the tip. The outer layer of the skin is at once removed and the fiber remains. It is rarely necessary to scrape the ribbon more than twice; the first scrape is often sufficient. When a dozen ribbons have been operated upon, the workman scrapes off the cuticle from the six inches remaining at the butt end, scraping in this case in the opposite direction. The fiber is hung up until a sufficient quantity has accumulated, and then spread out on bamboo poles in the sun and wind to dry and bleach."

In order to produce ramie commercially in the countries of the western hemisphere where wage standards are relatively high, it is going to be necessary to mechanize a large part of the production processes. The production sequence of ramie fiber is harvesting, decorticating (fiber removal from the plant), degumming, bleaching, and softening.

Planting, cultivating, and harvesting of the plants present no particular problems except that the harvester must incorporate some device for stripping the leaves and branches from the stems. The strippings may be returned to the field for their fertilization value or they may be gathered and processed into animal feed.

The greatest stumbling block throughout the history of ramie has been the development of suitable decortication equipment to separate the fiber strands from the bark of the plant. The best fiber is obtained if the plant is decorticated while green. Within a few hours after harvesting the outer bark hardens and turns brown and it is then extremely difficult to remove the fiber. M. Faure of France designed the first fairly feasible machine; the stems were crushed and a flat ribbon was produced. The ribbon was then split apart by teeth on a spiked cylinder. This combing action removed a large part of the woody matter.

Many attempts have been made to adapt such decorticators as the Krupp Stella and the Corona to the decortication of ramie, but the results have not been too satisfactory. Excessive waste, low production, and injury to the fiber are the main disadvantages of the machines produced to date. So far as it is known, there is no machine built today that can really be applied successfully to the decortication of ramie on a commercial scale.

Ramie fiber, as it comes from the

(Please turn to page 24)

	Alpha Cellulose	Ash	Soluble in 10% KOH	Copper Number	Beta and Gamma Cellulose
	%	%	%		%
Degummed Ramie Fiber	96.01	0.11	4.24	0.79	[b]3.88
Highly Purified Wood Pulp[a]	95.08	0.08	5.45	1.04	......
Rayon pulp now on market[a]	87.76	0.12	11.39	1.93	......

[a] Schwarz, E. W. K. and H. R. Mauersberger, Rayon and Synthetic Yarn Handbook (1936) 53.

[b] Estimated by difference.

Analysis of degummed ramie fiber compared with that of commercial rayon pulp.

(Continued from page 22)
mechanical decorticators, is in long strands approximately the length of the plant stem. These strands are composed of individual ramie fibers tied together with various resins and gums. Well decorticated fiber strands will contain not more than 20 per cent resin and gum.

To reduce the fiber to usable form, the decorticated strands must be degummed. There are many secret trade methods for degumming the fiber, but nearly all of them are based on the use of caustic soda, which has a tendency to weaken the fiber. The fiber strands are boiled in soda lye, steeped in a chloride of lime solution, and then placed in a hydrochloric acid bath; the fiber is washed, of course, between dippings. The latter two operations are repeated until all of the gum is removed and pure white fiber remains.

Quite often the strands are not completely degummed, but only part of the gum is removed so that fibers longer than the component fibers themselves remain. The degree of degumming will depend upon the ultimate use of the fiber. Following the degumming process, the natural suppleness of the fiber is restored by steeping the fiber in a glycerine-wax-tallow solution.

Composition	Per Cent
Cellulose (Ash Free)	83.51
Alcohol-Benzol extract	2.15
Cold water soluble	3.57
Alkali Soluble	9.95
Ash (in cellulose)	0.21

Composition of decorticated ramie fiber calculated on dry weight.

A large amount of money, time, and effort has been devoted to searching for a better degumming process than the caustic soda method, one that would be more economical and eliminate the weakening action of the caustic soda on the fiber.

No particular problems are presented in the bleaching and softening of the fiber.

Many large industrial concerns in the United States interested in ramie as a raw material are using it at the present time, and will find many other uses for it as soon as it is commercially available in sufficient quantity.

When processes and equipment are developed for economically producing ramie fiber in large quantities, the ramie growing industry will mushroom in the western hemisphere. Owing to its superior qualities and versatility, and to the fact that it is used mainly in high quality products, a relatively high price on this fiber is justified.

The development of the necessary processes and equipment for mechanically separating the ramie fiber from the plant and the solution of the chemical problems of degumming offer a real challenge to modern industrial research.

Alumni Support of Colleges

(Continued from page 9)
count of the work being done to test golf balls, the studies of dynamic strains and stress during the cycles of artillery firing, the investigation of the plastic behavior of structural steel, the tests of porcelain enamel, the effort to remove odors, and the alleviation of water noise in pipes and valves. I ask you, in all seriousness, is there anything that Illinois Tech is not investigating.

The industry of which I have the privilege of being a part owes much to Illinois Tech.

In 1941, after an intensive two-year study by a group of outstanding leaders of the gas industry, the Institute of Gas Technology was organized as a non-profit Illinois corporation and affiliated by agreement with Illinois Institute of Technology. Illinois Institute of Technology was selected by the gas industry as the most desirable engineering school in America to fulfill the purposes of the Institute of Gas Technology. Under the terms of the affiliation agreement, the president of Illinois Tech is made the president of the Gas Institute and Illinois Tech agrees to grant degrees to the graduate students of the Gas Institute who have completed satisfactorily a course of study of four academic years in length plus three summers of employment in the gas industry.

The Institute of Gas Technology is thus fulfilling, through its affiliation with Illinois Tech, the prime purpose of its organization, namely: to train a selected group of chemists and chemical engineers at the graduate level to take positions of leadership in the gas industry. In addition to the training of personnel, the Institute of Gas Technology is continually engaged in most significant research projects of great current importance to the gas industry, including the study of the complete gasification of coal, various catalytic cracking processes, etc., all designed to develop more efficient and expeditious methods of gas production to meet peak requirements. There is now in operation at Riverhead, Long Island, a gas manufacturing plant which is using a catalytic cracking process (for which great hopes are held) developed by the Institute of Gas Technology.

The Peoples Gas Company could not operate tonight in meeting a great human need for the vast population of Chicago without the skill, ability, and experience of 137 graduates and former students of this institution and its predecessors—Armour and Lewis. These 137 men, who are my associates at the Peoples Gas Company, include men in all of the divisions and departments, including the president of the company, Mr. George F. Mitchell, and the operating vice president, Mr. Karl B. Nagler. I am delighted to note the presence here tonight of my associates at Peoples Gas: Ernest S. Beaumont, Edward F. Pohlmann, Frank P. Mueller and Robert Wight.

A private college is now primarily dependent for its growth and support upon its alumni, who are the members of the college family. In days gone by . . . and they may have been happier . . . college institutions obtained their support in part from tuition fees; but since education is needed and deserved by the less well-to-do, the greatest part of the support has, in the past, come from income on endowments. These endowments came to the institutions as the result of substantial gifts made by the very wealthy, either during their lifetime or by bequests effective on death. Many factors have intervened which have destroyed reliance upon endowment income as the material resource to maintain the independent educational institutions.

We hear much currently of the profound and serious economic consequences of a tax policy which seriously limits venture capital upon which industrial and economic growth is dependent. More could be said, with equal effect, of the consequences of a tax policy which is rapidly liquidating large fortunes and preventing the accumulation of new fortunes, the absence of which will prevent an increase in endowment support for private charitable and educational institutions.

I have recently received figures from Princeton University, my own alma mater, which seem to me to be typical and significant. Between June, 1939, and June, 1947, a period of only eight years, Princeton's endowment increased $10,000,000—from $35,000,000 to $45,000,000—an increased of 28 percent. The endowment income, however, increased only 18 percent—from $1,200,000 to $1,400,000—while the

(Please turn to page 28)

DU PONT *Digest*
For Students of Science and Engineering

Many Theoretical and Applied Studies Behind Development of "Cordura" Rayon

Stronger, lighter tires made possible by teamwork of Du Pont chemists, engineers, and physicists

On the surface, the viscose process for rayon seems fairly simple. Cellulose from cotton or wood is steeped in NaOH to give alkali cellulose, which is treated with CS_2 to form cellulose xanthate. Adding NaOH gives molasses-like "viscose," which is squirted through spinnerets into a coagulating bath of acid and salt to form from 500 to 1,000 filaments simultaneously:

$$\underset{\text{(cellulose)}}{R^{*}\text{-OH}} + NaOH \longrightarrow \underset{\text{(alkali cellulose)}}{R\text{-ONa}} + H_2O$$

$$R\text{-ONa} + CS_2 \longrightarrow \underset{\text{(cellulose xanthate)}}{R\text{-O-}\overset{\overset{\displaystyle S}{\|}}{C}\text{-SNa}}$$

$$R\text{-O-}\overset{\overset{\displaystyle S}{\|}}{C}\text{-SNa} + H_2SO_4 \longrightarrow \underset{\text{(cellulose)}}{R\text{-OH}} + CS_2 + NaHSO_4$$

$$R^{*} = C_6H_7O_2(OH)_2$$

Du Pont scientists were working to improve on the properties of rayon made by this process when, in 1928, a rubber company asked for a rayon yarn that would be stronger than cotton for tire cords. The problem was given to a team of organic, physical, and analytical chemists, chemical and mechanical engineers, and physicists.

Theoretical and Applied Studies

In developing the new improved rayon, a number of theoretical studies were carried out: for example, (1) rates of diffusion of the coagulating bath into the viscose filaments, (2) the mechanism of coagulation of viscose, (3) the relationship between fiber structure and properties by x-rays, and (4) a phase study of spinning baths.

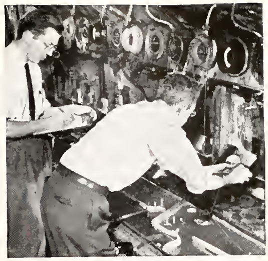
Concurrently, applied research was necessary. This proceeded along many lines, but the main problem was to perfect the spinning technique. It was known that a short delay in the bath between the spinneret and the stretching operation allowed greater tension on the filaments. Du Pont engineers, therefore, designed a series of rollers, each revolving faster than the previous one, to increase the tension gradually.

In addition, a textile finish was developed that combined just the right amount of plasticizing action and lubricating power, allowing the filaments to twist evenly in forming the cord. A new adhesive was prepared to join the yarn with rubber. New twisting techniques for cord manufacture were found, since the usual methods caused loss in rayon strength.

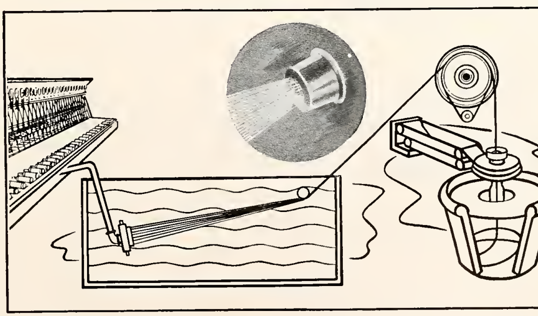
Engineering Problems Solved

Chemical and mechanical engineers were faced with the design and operation of equipment for more than 15 different types of unit operations. Equipment had to operate every minute of the day, yet turn out perfectly uniform yarn. It was necessary to filter the viscose so carefully that it would pass through spinning jet holes less than 4/1000th of an inch without plugging. Some of the most exacting temperature and humidity control applications in the chemical industry were required.

Out of this cooperation among scientists—ranging from studies of cellulose as a high polymer to design of enormous plants—came a new product, "Cordura" high-tenacity rayon, as strong as mild steel, yet able to stand up under repeated flexing. Today, this yarn is almost 100% stronger than 20 years ago. Tires made with it are less bulky and cooler running, yet give greater mileage under the most punishing operating conditions. In "Cordura," men of Du Pont have made one of their most important contributions to the automotive industry.



Determination of spinning tension by C. S. McCandlish, Chemical Engineer, Northwestern University '44, and A. I. Whitten, Ph. D., Physical Chemistry, Duke University '35.



Rayon spinning machine. The spinning solution is pumped through a spinneret immersed in a hardening bath. Filaments are guided over a rotating glass wheel and down into the whirling collecting bucket. Inset shows close-up of spinneret; each hole forms a filament.

(Continued from page 26)
total annual expenses of Princeton increased from $3,000,000 to $7,000,000, or an increase of 139 percent. During this period, the endowment income dropped from 40 percent of such expenses, and tuition fees dropped from 41 percent to 30 percent of the expenses. These facts create a vacuum, and spell disaster for Princeton and Illinois Tech as independent institutions unless new and reliable sources of continuing financial support are found from private sources.

To fill this vacuum, the educational institution must turn to its sons, the members of its alumni, who owe it the greatest debt and who, as a group, can supply the resources to maintain the institution. The experience of Princeton has been significant. Annual giving by alumni was instituted in the academic year of 1940-1941, during which period 3,500 alumni provided $80,002. This participation has gradually grown until in the academic year of 1946-1947, 8,450 alumni contributed $231,000. The goal at Princeton this year is $250,000, and ultimately $1,500,000 per annum.

It will readily be seen that relatively small amounts given regularly by large numbers of alumni can be the equivalent of vast endowment funds which are now not prospectively obtainable.

The record of Illinois Tech is equally impressive. Your alumni giving also started in 1941 when 26 percent of the alumni of Illinois Tech contributed in excess of $50,000. In 1947 almost 3,000 alumni of Illinois Tech contributed in excess of $117,000. There is one desirable feature of the present tax policy which encourages this growth: that is, the deductibility of such gifts in the computation of federal taxes on income.

Reference was made a moment ago to happier days. Maybe this is an erroneous statement. Perhaps the real happy time is when every alumnus of every educational institution accepts his responsibility annually, and by regularly contributing relatively small amounts, participates in the development and growth of the institution of which he is a member. Perhaps this situation is more wholesome and healthy than where, as in the past, the institution has been financially dependent upon the purse-strings of the wealthy few. Certainly it is more healthy than a surrender to government subsidy.

As the alumni of your institution and mine contribute regularly to our respective institutions, these institutions will necessarily mean more to us, and the more they mean to us, their Alumni, the finer, stronger, and better they will be.

I congratulate you upon your enthusiastic approach to a great work, and predict a new record for 1948. May I leave you with the story of the group of old residents sitting in the Vermont store. One of their number had recently died. He was reputed to be a rich man and his friends were acrimoniously debating the extent of his wealth. Finally old Joshua said, "I know exactly how much Seth left. He left all of it."

Members of Sigma Kappa sorority gather for a song session. Sigma Kappa is one of the two national sororities at Illinois Tech.

Extracurricular Activities . . .

(Continued from page 12)

the Radio Club, the Airplane Model Club, and the Musical Clubs, are also quite popular.

The need for workshops, laboratories, and meeting places for these hobby and recreational groups is great, and their future development is dependent somewhat upon the ability of the college to provide space in which they can operate.

The nucleus of these organizations, in fact, the main support for all activities, comes from the fraternities. Nine of the twelve fraternities have already become affiliated with national organizations; three operate as local organizations and one of these three is at present negotiating with a national organization. Last fall, many more men were denied admission to fraternities than it was possible for the twelve groups to accept. Consequently, the Interfraternity Council recommended that an additional fraternity be invited to establish a chapter at Illinois Tech. Recently the college added one such group.

The fraternities are doing a particularly fine job and all are in excellent condition. They are operated under the authority of the dean of students and through an interfraternity council composed of undergraduate representatives from each fraternity. An organization made up of an alumnus of each group gives valuable guidance and advice. This council serves in an advisory capacity and meets regularly with the dean of students.

While eight of the fraternities are in a position to assume responsibility for the maintenance of fraternity houses, the Institute has been able to supply only six with permanent quarters. Of the six, two own their own houses, one rents from a private owner and three rent from the college. All are attractively furnished and house from 20 to 40 men each. Plans for the development of the new campus include quarters for these fraternal bodies, and it is expected that they will continue to play an important role in the program.

From time to time, fraternities have been the target for rather bitter criticism. These complaints have not always been unjustified, at least on a national scale. Fraternities frequently have been on one side of the fence and the college on the other. They have been called the mecca for the rich boys who preferred to look upon colleges as country clubs and the fraternities as places for hazing, snobbery, and other non-acceptable practices. There has been a change of attitude recently on the parts of both national fraternities and college administrators, and a definite trend in an opposite direction is noticeable.

Illinois Institute of Technology looks upon fraternities as an integral

(Please turn to page 32)

RCA scientists—pioneers in radio-electronics—apply the "radio tube" to communications, science, industry, entertainment, and transportation.

This "magic lamp" makes Aladdin's look lazy

You will remember the fabulous lamp—and how it served its master, Aladdin. Serving you, today, is a real "magic lamp" . . . the electron tube.

You are familiar with these tubes in your radio, Victrola radio-phonograph or television set . . but that is only a small part of the work they do. Using radio tubes, RCA Laboratories have helped to develop many new servants for man.

A partial list includes: all-electronic television, FM radio, portable radios, the electron microscope, radio-heat, radar, Shoran, Teleran, and countless special "tools" for science, communications and commerce.

The electron microscope, helping in the fight against disease, magnifies bacteria more than 100,000 diameters, radar sees through fog and darkness, all-electronic television shows events taking place at a distance, radio-heat "glues" wood or plastics, Shoran locates points on the earth's surface with unbelievable accuracy, Teleran adds to the safety of air travel.

Constant advances in radio-electronics are a major objective at RCA Laboratories. Fully developed, these progressive developments are part of the instruments bearing the name RCA, or RCA Victor.

• • •

When in Radio City, New York, be sure to see the radio, television and electronic wonders at RCA Exhibition Hall, 36 West 49th Street. Free admission. *Radio Corp. of America, RCA Building, Radio City, N. Y. 20.*

Continue your education with pay—at RCA

Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

• Development and design of radio receivers (including broadcast, short wave and FM circuits, television, and phonograph combinations).

• Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.

• Design of component parts such as coils, loudspeakers, capacitors.

• Development and design of new recording and reproducing methods.

• Design of receiving, power, cathode ray, gas and photo tubes.

Write today to National Recruiting Division, RCA Victor, Camden, New Jersey.

Also many opportunities for Mechanical and Chemical Engineers and Physicists.

RADIO CORPORATION of AMERICA

(Continued from page 30)
part of student life. Not only does the college administration accept, but it enthusiastically supports the fraternities and their programs. In exchange, however, for this interest and support, the college has charged the fraternities with certain responsibilities and proceeds on the thesis that the two parties are in one boat rowing together. These fraternal bodies submit monthly financial statements to college authorities and meet specified membership requirements. Those maintaining houses are regularly inspected for safety and cleanliness, and each has either a housemother or proctor.

The housemothers or proctors are approved in advance by the college authorities and, once elected by the fraternities, are responsible only to the dean of students and the alumni advisors of the chapter. They are neither detectives nor disciplinary officers; their function is to help the men of the fraternities become better students, better fraternity members, and better gentlemen. Inaugurated last September, this plan for housemothers or proctors is still too new to permit a conclusion as to its effectiveness. However, it gives every indication of becoming a vital and significant step in the right direction. Although fraternity members at first disliked the idea of this system, they have always given complete cooperation and in most cases are now convinced of its value.

We believe, as does the National Interfraternity Conference, that "the college fraternity has as its goal, in harmony with that of the college, to provide training and discipline of the individual who, in seeking an education, desires to make of himself a useful member of society, possessing knowledge, trained skill, and capacity for accomplishment. The college fraternity, as a group organization, seeks to train men how to live and work together, striving by precept and example for the personal development of the individual in the training of mind and body. It carries forward the fundamental purposes of education, adding a fraternal influence for correct living and individual development."[3]

Illinois Tech fraternities are making an earnest effort toward that end; and so long as this is the case, they will be given hardy endorsement.

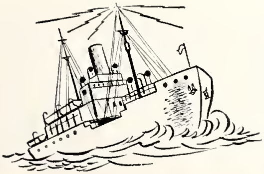
Along with the fraternities, three sororities, two or which are national, are active on the campus and play an important part in the program for women. While the present enrollment of women students is relatively small, a definite effort is being made to increase the number. Illinois Tech, through Lewis Institute, has always had an excellent home economics department and other highly rated curricula in a wide academic program which can serve women students. It is imperative, therefore, that we sponsor a sound extracurricular program to supplement the formal education of the woman student.

The Illinois Tech Women's Association was organized a year ago with this objective. Every woman enrolling in the institution automatically becomes a member of ITWA and, through its acitvities, is urged to join some organization or take part in some activity of interest to her. Teas, receptions, dances, and other social events have been sponsored by this group. Although relatively small in number, women students have taken a real lead in campus activities. Representatives serve on the student governing board and a significant position has been assumed by them in such all-college activities as Junior Week, the newspaper, and other outlets. The sororities have acted as the spearhead for this interest.

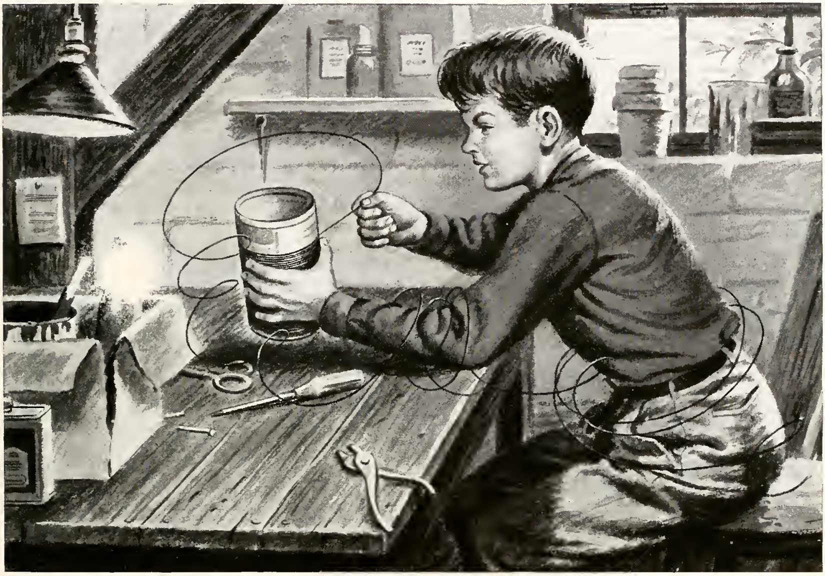
It should be emphasized again that sororities and fraternities have served as the driving force for all campus activities. It has been said by some that student affairs are controlled by the "Illinois Tech 400". To a large degree, this is correct; furthermore, it is true that the vast majority of the "400" students are members of social fraternities and sororities. Membership in those groups places the individual in a closely knit organization which can and does direct the interests of its membership. Such a group, if it is worth its existence, is interested not only in improving the scholarship of its members, but also in seeing that they participate in campus activities. Obviously, it is through that leadership that the fraternity gains its reputation. At the same time, unless it offers this type of program to its membership, it has little reason for being. Students in an institution of Illinois Tech's size and character who have no fraternity or social ties have little impetus to become activity-minded. Except in rare cases, they become "commuters" whose only interest lies in classroom activity.

Another reason for the fraternity and sorority leadership in the extracurricular program is the fact that, until now, they have offered the only
(Please turn to page 34)

[3] "The Decalog of Fraternity Policy", National Interfraternity Conference, New York.



Who named it wireless?



The ether which brings mysterious electrical impulses across the miles to your radio, has always enveloped the earth. It was there when Noah launched his Ark. So were all the elements that combine to make this modern miracle. But Noah's only contact with the outside world was a Dove.

Today any teen-aged youngster knows more about the subject than did Noah, yet, relatively speaking, we know as little about electricity as he did. We haven't scratched the surface.

Roebling saw the future of electricity and recognized the important part it would play in American industry, sixty-eight years ago. Roebling undertook the manufacture of electrical wires and cables in 1880 because it had confidence in America's future, and because it knew that individual enterprise and free competition speedily would create a steadily growing demand for its product. Roebling has consistently led the way in the design and manufacture of electrical conductors.

Roebling electrical wire and cable enjoys the well-earned confidence of electrical men—not only in this country—but throughout the world.

JOHN A. ROEBLING'S SONS COMPANY
TRENTON 2, NEW JERSEY
Branches and Warehouses in Principal Cities

A CENTURY OF CONFIDENCE **ROEBLING**

(Continued from page 32)

real opportunity for housing on the campus. It is difficult for a student to participate in the affairs of various clubs and recreational groups when he must spend from a half-hour to two hours on public transportation at the end of the day. "Street-car" students are generally not leaders for the reasons mentioned above. A student who lives on the campus and spends 24 hours a day living his college life is much more inclined to take advantage of extracurricular opportunities. It means, too, that going to college *is* his life rather than merely his full time job. The result is that he will create new friends and new interests rather than merely absorb information.

The development of the Institute's housing program will mean a great deal to the further development of a well-rounded educational program. With a larger percentage of the students living on the campus, one can expect a larger participation in the extracurricular portion of the education program. We expect that these new residents not only will be incorporated into the activities which already exist, but that other activities stemming from the housing units themselves will be developed.

The well-organized and intelligently-led discussion or "bull session" has traditionally been a part of college life. Such sessions, except in fraternities, have had little opportunity to exist on the Illinois Tech campus and will almost certainly come into their own with the development of the dormitory system. With the increased number of students living on the campus and participating in activities, one can expect that the "Illinois Tech 400" will no longer exist and that this larger group, exerting its influence on the student program of the college, will broaden its base and make it more attractive to all students.

When one finds the control of and participation in activities resting with a relatively low percentage of the total student body, he finds another and rather serious problem—the relatively small group of student leaders lead everything.

As an example: the editor of the yearbook is also the chairman of the Publications Board of Control, member of the Illinois Tech Student Association board of control, president of the senior class, and member of a social fraternity.

Another student is president of the journalism honorary fraternity, member of Alpha Phi Omega service fraternity, president of his social fraternity, member of Chi Epsilon honorary fraternity, treasurer of the student chapter of the American Society of Chemical Engineers, and member of the Interhonorary Council, and he also works as a student in one of the major administrative offices of the college. In the past, he has held offices in a number of these organizations, was editor-in-chief of the newspaper, a member of the Honor Board, and has always been extremely active in non-organized student activities.

(Please turn to page 36)

A new doorway to Petroleum Progress

No illustrations can do more than suggest the wealth of facilities at Standard Oil's new research laboratory at Whiting, Indiana. Here, in one of the largest projects of its kind in the world, there are provided the many types of equipment needed and desired for up-to-the minute petroleum research.

The caliber of the men who work here is high. For many years, Standard Oil has looked for and has found researchers and engineers of high professional competence. Further, the company has created for these men an intellectual climate which stimulates them to do their finest work.

And there is nothing new about the idea that motivates Standard Oil research. It is simply that our responsibility to the public and to ourselves makes it imperative to keep moving steadily forward. Standard Oil has always been a leader in the field of industrial research; the new Whiting laboratory is proof of our intention to remain in the front rank.

STANDARD

STANDARD SERVICE

Standard Oil Company

(INDIANA)

910 S. Michigan Avenue, Chicago, Illinois

(Continued from page 34)

In both these cases, the men earned grade point averages higher than the all-college average, but it could be legitimately argued that they might have done a better academic job had they not participated in so many activities. Another point of view is that, by holding these jobs, they eliminated the possibility of other students gaining the benefits of participation in activities.

This over-concentration on the part of some students has been a source of constant discussion, not only on the Tech campus but on the campus of every college in the country. In the last analysis, one always comes back to the conclusion that "those who can lead, will lead". Point systems limiting such participation have been evolved in some colleges, but they never have been completely satisfactory. In the Illinois Tech situation, the program has not yet reached the point where those responsible can even seriously consider such a possibility.

Rightly or wrongly, Illinois Institute of Technology student leaders always say "if we don't do it, who will"? That argument, of course, may be based on a false assumption.

In evolving a point system there is one great problem: the inability to measure the relative time spent in membership compared with that of being an officer in an organization, and the even greater difficulty of measuring the load between one organization or activity and another.

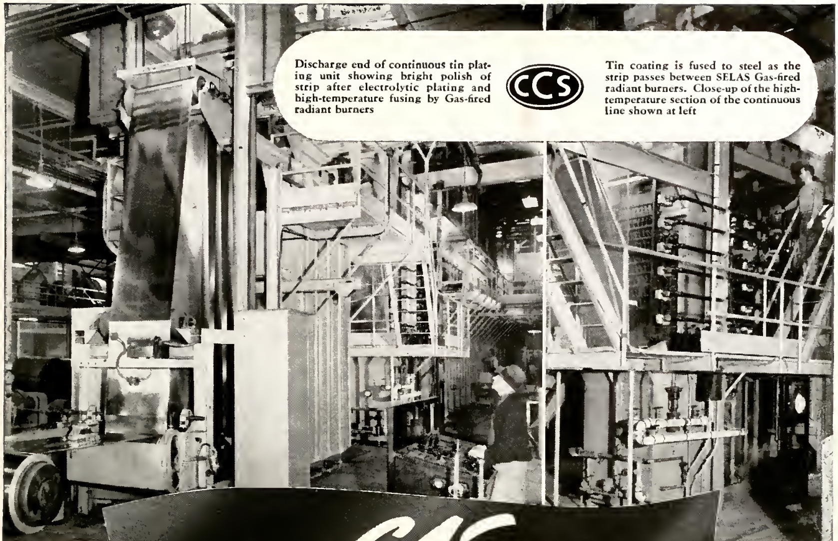
If a point system is adopted, one is forced to decide whether the editorship of the yearbook is as time-consuming as the editorship of the newspaper; or whether the sports editorship of the newspaper is as heavy a load as the presidency of a fraternity. Obviously, the presidency of a fraternity or an editorship is more time-consuming than playing in the orchestra or being treasurer of one's class; but evolving that difference in load into a specified system of points is much easier said than done. In education, as in life, we cannot overlook the human factor. There is always the individual who can and should spend more time studying course work. There is also the student who can and who should participate in more activities and take a lead in more functions than the man who may sit next to him in the classroom.

A point system would forbid the evaluation of such individual differences. Students on academic probation are barred from holding any office or representing the Institute in any activity, but the problem is to make the potential "B" student a "B" student rather than a "C" student and, at the same time, help him become a well-rounded citizen of the community. This cannot be accomplished by simply evolving a set pattern into which each individual student must fall.

Therefore, one comes back to the original conclusion: in planning each student's program, both curricular and extracurricular, he must be treated as an individual. But it is difficult, if not impossible, to contact and influence every individual student. The answer seems to lie only in the development of a two-fold program which will permit more students to spend more time on the campus, and an adequate counselling system to direct students' interests into proper channels.

Even dormitories and fraternity houses will not solve the problem unless the college administration lends its influence to the development of student activities. A greatly expanded student personnel program is needed, and such a program is already underway. We hope that eventually every student at Illinois Tech will carry not only the specified curricular requirements for a degree but will also participate in his share of student activity.

The college firmly believes that it is on its way toward that goal. How long it will take, one dares not forecast. The brightest spot in the picture is a realization of the problem and the unity of students, faculty, and administration in working toward its solution.



The Future of Materialism

(Continued from page 13)

terialism. Berkeley maintained that whatever is perceived is something mental and that the very existence of the object consists in its being perceived. Thus he denied the existence of material objects apart from the mind of the perceiver. The weak point in his argument is that he does not deny the existence of a thing when he does not perceive it, but states that it must exist in other minds. Here, however, he invokes the testimony of minds other than his own, thus giving these objects an objective independent existence. But his first postulate compels us to admit that our belief about other minds is again an idea in our brain. Various other objections have been pointed out by modern philosophers like Bertrand Russell, who shows that there is a confusion of the object and the thought of the object.

It is not my purpose here to discuss the validity of the idealist philosophy, but merely to state that an attempt has been made during recent times by certain scientists (perhaps all physicists) to return to the idealist philosophy in a modified form, basing the arguments on developments in modern physics; and it is worthwhile to note what it is in modern science that does not fit in with the materialist doctrines of the nineteenth century.

Let us first of all examine the developments in modern physics, for it is here that the twentieth century has witnessed two great revolutions. The Theory of Relativity and the Quantum Theory are generally regarded as the two important developments of philosophical consequence. Even before the advent of relativity, physicists developed the field theories to describe electrical, magnetic and gravitational phenomena, but the atomistic point of view still remained the dominating influence in shaping the philosophical beliefs of the nineteenth century. Nor did the discovery at the beginning of this century that atoms are not indivisible, but that they are composed of a number of still tinier particles called electrons, protons (and now neutons, also), bring about a change in our outlook; it merely involved a substitution of these new particles in the old place of the atoms in our picture of the material universe.

While for obvious reasons we cannot go into the details of the Theory of Relativity here, we can still consider the possible manner in which relativity can bring about an alteration in our philosophical ideas. One of the results of the special theory of relativity is the discarding of the conception of space and time as having unique independent existences. Each observer (the observer need not be a human being but may be a recording instrument) is shown to possess his own private system of space and time for the description

(Please turn to page 40)

(Continued from page 38)

of natural phenomena and it is pointed out that no one observer is in a more privileged position than the other. Thus it comes out that the time interval between two events is not an invariable magnitude but that it depends upon the observers. This point has been made the basis of an argument that if an event A happens earlier than an event B according to one observer, and according to a second one the event B precedes the event A, not only is the time interval between the two events not a definite magnitude, but the order of the events is altered also. How then can the law of Causation (which is at the basis of materialist philosophy) be held true? The fallacy, however, lies in supposing that any two events can have their time order reversed for suitably moving observers. As a matter of fact, events which are causally connected can never have their time order reversed whatever the motion of the observers. Relativity, indeed, does not assert (as is supposed by some) that everything is relative; rather, relativity distinguishes the invariable from the variable, and in respect to this lies the importance of the substitution of space-time for space and time.

Among the other consequences of relativity there is the equivalence of mass and energy, which in pre-relativity physics were regarded as independently conserved. It therefore follows, as a result of this relationship, that mass can disappear and reappear as energy or vice versa—a prediction which has found ample experimental evidence in atomic physics. It was found that an electron and a positron may annihilate each other and appear as radiation. The converse effect of the materialization of radiation has also been observed, as for instance when a γ-ray photon materializes into an electron and a positron.

While the old idea of the concreteness of mass has been dwindling in the light of relativity, still another stab has been made by the more recent developments of quantum mechanics. It has been found necessary to attribute wave-like properties to matter on one hand and matter-like (corpscular, as it is called) properties to waves of radiation on the other hand. In the new Quantum Theory developed by Schrodinger, Heisenberg and others, electrons and protons have lost their concreteness and are replaced by waves—waves of probability.

While matter was thus becoming more and more shadowy, Heisenberg enunciated his famous principle of indeterminancy. In non-mathematical terms the principle amounts to the statement that it is impossible at the same time to state precisely the position and velocity of an electron and that the product of the uncertainties in the determination of each is always greater than, or (at best) equal to, the Plank's quantum of action, h. This is not merely a statement regarding the inaccuracy of our experiments but establishes the theoretical limits beyond which we cannot hope to make our measurements. In view of this, most of the laws of classical physics came out to be what are generally known as statistical laws, from which alone the behavior of individuals cannot be determined. Let me take an example of this: from the death rate which is found to prevail in a particular place it is possible to give a fairly correct figure as to how many people die in a year in a particular city, but if the particular persons who would die in a certain year are asked to be named, it is at once found to be impossible. The well known Second Law of Thermodynamics is itself an example of this statistical type of law.

The nineteenth century ended with the firm conviction that matter, composed of electrons and protons, is alone real, and that the explanation of all natural phenomena is to be sought in the behavior of these particles obeying perfectly definite laws. The twentieth century witnessed the view—forced upon on one hand by the Theory of Relativity and on the other by the Quan-

(Please turn to page 42)

(Continued from page 40)

tum Theory—that matter behaved as waves under certain circumstances, and as particles, whose position and velocity cannot be known with absolute certainty, even in theory, in other circumstances. With this scientific background, the old idealist philosophy and the pre-Darwinian creation theory of the world have forced their way from an altogether different route. From the Second Law of Thermodynamics, which states that the universe is becoming increasingly random with the passage of time, Sir James Jeans postulates the creation of the universe. The probable time according to Jeans is, of course, far greater and on an astronomical scale compared with the time given by Edmund Goese's father who argued that the world was created in 4004 B.C.

Further, the freedom of will which found no support in the strict mechanistic pre-determination of the classical physics, was rescued by the atomic indeterminacy. The unpredictability of the behavior of individual atoms has been made the basis from which, by a logical chain of reasoning, the freedom of the human mind can be established. Thus, according to one group of scientists, the philosophical outcome of science seemed to be not much different from the idealist philosophy, though the conclusion was arrived at in an altogether different way.

While the progress of physics all along the twentieth century has been a retreat from the materialistic view, biology and psychology have taken an apparently different path. While the behavior of inorganic matter appeared to be less and less predictable, biologists have been, in general, trying to explain the functions of the living organism in terms of its constituents, and have done so with notable success. One cannot help asking what light the new developments of physics have thrown on the issue of whether living and non-living matter are essentially alike or different. Physics has never observed in the study of even the tiniest particles, electrons, protons, etc., of which all known bodies are composed, anything similar to that we call life. Nor have the most ardent vitalists ever been able to isolate life from matter. Perhaps much of the unnecessary discussion might be avoided if we would remember that a group of entities might exhibit properties which may not be characteristic of the individuals that compose the group. Everyone knows that a gas possesses properties like pressure, temperature, entropy, etc., which cannot be independently exhibited by the molecules that compose it. So, too, life and its attendant attributes may simply be properties of the atoms, depending in some as yet unknown way upon their arrangement.

One need not imagine any incompatibility between the developments of biology and those of physics. No fact has ever been found in biology that does not fit in with the laws of

(Please turn to page 44)

"Intellectual improvement arises from leisure"—SAMUEL JOHNSON

Why housekeeping gets "lighter" all the time

". . . Woman's work is never done."

True enough. But today's homemaker—aided by her modern refrigerator, range, water heater, vacuum cleaner and other appliances finds more time for family and for leisure.

And what helps these "automatic servants" operate so dependably? *Better materials* for one thing.

Materials on the inside—the unseen working parts of household standbys. Such as alloy steels, new plastics, carbon brushes in motors . . . lighter, more compact materials that make appliances stand up longer and handle with ease.

Materials, too, that you can see . . . as those stainless steel surfaces so easy to clean. Or the chemicals in more enduring waxes and polishes, varnishes and plastic finishes.

Yes, today's housewife enjoys new leisure, new freedom from drudgery . . . thanks to better materials.

Producing these better materials and many others—for the use of science and industry and the benefit of mankind—is the work of the people of UNION CARBIDE.

FREE: *You are invited to send for the illustrated booklet, "Products and Processes," which describes the ways in which industry uses UCC's Alloys, Chemicals, Carbons, Gases and Plastics.*

UNION CARBIDE
AND CARBON CORPORATION

30 EAST 42ND STREET UCC NEW YORK 17, N. Y.

Products of Divisions and Units include

LINDE OXYGEN • PREST-O-LITE ACETYLENE • PYROFAX GAS • BAKELITE, KRENE, VINYON, AND VINYLITE PLASTICS
NATIONAL CARBONS • EVEREADY FLASHLIGHTS AND BATTERIES • ACHESON ELECTRODES
PRESTONE AND TREK ANTI-FREEZES • ELECTROMET ALLOYS AND METALS • HAYNES STELLITE ALLOYS • SYNTHETIC ORGANIC CHEMICALS

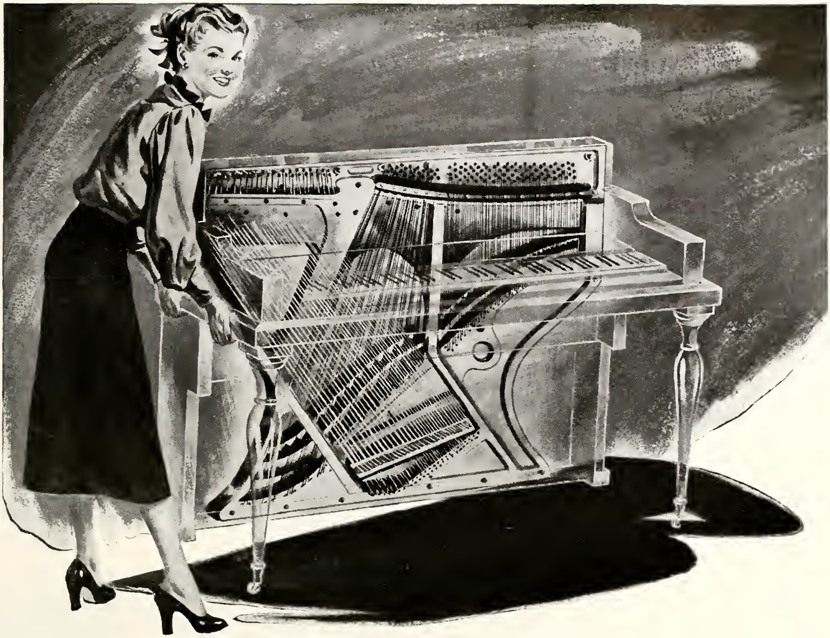
(Continued from page 42)

physics. The uncertainty about the behavior of the individual atoms need not force us to give up our attempt to explain the behavior of the living organisms in terms of its constituents. Even the smallest living cell is composed of vast numbers of atoms, whose behavior as a group can be determined without violating the principle of indeterminancy.

Thus, while the controversy between pre-determination and free-will and mechanism and vitalism has not yet received a satisfactory solution, a powerful group of experimental psychologists known as Behaviorists, led by Dr. J. B. Watson, have been making relentless attacks against everything that is considered mental as opposed to material. Born in America, Behaviorism rapidly established itself all over the world both as a powerful method (the only reliable one according to Behaviorists) of observation and as a philosophy. The Behaviorists start from the assumption that what can be learned from objective observation alone is significant, thus ruling out the possibility of introspection as a method of attaining knowledge. They, therefore, set out to explain every action in terms of the stimulus-response theory; and, if for no other reason, the success which they have achieved is sufficient reason to claim for Behaviorism a place in any philosophical discussion. Many of its doctrines have the peculiar charm of appealing to the rational type of mind in spite of their apparent contradiction to traditional ideas. For example, Behaviorists reduce thinking—an accepted mental faculty in academic psychology—to what they call sub-vocal speaking and correlate it with movements of the muscles of the larynx. Our emotions, feeling, memories all have, according to them, their Behavioristic equivalents. Behaviorism thus appears to be the main development in the twentieth century in support of the materialistic viewpoint of all the recent scientific developments.

We have so far briefly examined the various philosophical trends in the important developments of science, and it is now our last business to consider the possible consequences of the philosophical outcome of science to human society. While the consequences of the discoveries of applied science to humanity are at once apparent, the effect of theoretical developments is not so obvious to the layman, although they are far more profound in the long run. We have just witnessed on a collossal scale the effect of the thoughtless application of physical science, but a similar application of biology and psychology may be far more dangerous, and if man is to evolve into a better type, he must learn to use science before he takes his evolution into his own hands. Aldous Huxley in his *Brave New World* has given a warning of the world that may emerge out of the application, or rather, misapplication of our present knowledge and power of science.

Science, it is often stated, cannot help us to decide the right thing to do, but can only state the result of such and such an action. When every conceivable problem the entire universe presents is answered by science, there still remains the most important task for mankind—to build a philosophy based on it, which alone can provide the basis for our values. If the purpose of science were merely to substitute one set of beliefs in the place of another, without suggesting a philosophical outlook—that deep-seated hunger of every enquiring soul—science would hardly have sustained the enthusiasm of the most patient explorers of truth, the scientists.



The Piano Business Gets a LIFT... when Alcoa Aluminum Castings Replace Heavy Metal

Even a well-trained husband who'll rearrange the living room every Spring balks at piano-moving. You can see the main reason above. It's the big metal plate that holds the strings—and it has always tipped the scales at around 125 pounds.

No wonder it gave the piano business a *lift* when a progressive piano builder replaced the heavy iron plate with one weighing 45 pounds—made of Alcoa Aluminum. As perfected, this big casting from our foundries is strong to resist the 18-ton pull of the taut strings. It is stabilized to provide tonal quality and stay in tune. And its cost today is competitive with the old-fashioned cast-iron plate.

With other advantages, in other industries Alcoa Castings are effecting similar changes. In one plant, their corrosion resistance means no painting, simple finishing. In another, they are liked for their superior machinability. In still another, they are preferred for the ease with which they swing through production, where iron castings had to be hauled by truck or hoisted on heavy cranes.

The change from heavy metal castings to Alcoa Aluminum Castings is a revolutionary switch in product engineering. Old, old habits are being questioned as engineers re-evaluate metals—with a sharper eye than ever before focused on Alcoa Aluminum. ALUMINUM COMPANY OF AMERICA, Gulf Building, Pittsburgh 19, Pennsylvania.

ALCOA FIRST IN **ALUMINUM**

ALCOA ALUMINUM 1888 1948 60 YEARS OF SERVICE

Just 60 years ago six young men started a tiny business in a little shed in Pittsburgh. They began to make aluminum by a new process. That was the beginning of what is now Alcoa. Alcoa's aim, then and now, was to make aluminum cheaper and more useful. How successfully that has been done is shown by the fact that America today has the greatest aluminum industry in the world, employing around 1,000,000 people in the manufacture of aluminum in its many shapes and forms or in making many useful products in which aluminum plays an essential part.

Trends In Industrial Research

(Continued from page 16)

industrial research for mid-continental industry, developing new uses for existing agricultural produce, and developing the resources of farm, forest, mines, and wells of the region are primary objectives.

The total research expenditures during the last fiscal year amounted to $450,000, demonstrating a remarkable growth in the three years of Midwest's existence. At the end of the fiscal year the staff numbered 100, of which 60 were technical and 40 were non-technical personnel. Midwest Research Institute is now conducting research in agricultural chemistry, organic chemistry, inorganic chemistry, physics, and engineering mechanics. At the present time there are 30 major research projects active, not including short-term investigations on advisory services to industry.

The Southern Research Institute at Birmingham, Alabama is a non-profit organization, founded in 1945, supported by private capital subscriptions and endowments, and making its services and facilities available to industry on a fee basis fully protecting the sponsor's interests. The Institute is doing industrial research in plastics, applied chemistry, physics, metallurgy, engineering, food technology, biochemistry, and organic chemistry.

Research expenditures for the year of 1947 will exceed $300,000, an increase of about $100,000 over the previous year. There are at present 40 active research investigations. During October, 1947, the research efforts were distributed as follows: 69% in industrial contracts; 15% for government agencies; 14% in the biochemistry of disease, and 2% on Institute sponsored research.

The organization of Southern Research Institute now consists of about 80 persons, of whom 48 are on the technical staff and 32 are on the service staff.

The Southwest Research Institute, an endowed organization for scientific study founded by Tom Slick, was dedicated September 11, 1947 on the Essar Ranch, 7 miles from San Antonio.

The new laboratory includes chemical and biological units, engineering departments, and a complete machine shop. Further expansion of facilities is expected as soon as materials are available. The second laboratory of the Institute, devoted to petroleum chemistry and technology, is expected to be located in Houston.

Although barely started, Southwest already has enough business to keep its present laboratories operating at near capacity. This expanding organization currently has a staff of 40. The Southwest Research Institute is the third and final part of a research organization which also embraces the Foundation of Applied Research, now working on agricultural and medical studies, and the Institute of Inventive Research, which aids inventors in developing their ideas.

Leading industrialists of California and the Pacific Northwest recently cooperated in the establishment of Stanford Research Institute, which is a non-profit organization designed to undertake any type of investigation needed by industry or government. It is equipped to study problems in business organization, industrial relations, personnel procedures and marketing, as well as to do technical research in physics, chemistry, engineering and biology.

(Please turn to page 48)

Biologists at work in the animal room of the biochemistry division, Southern Research Institute.

(Continued from page 46)

Under the plan, all companies, both large and small, may use the services of experts in a wide variety of fields to carry on independent research or to supplement their own activities.

While the organization is entirely separate from the university, it will, nevertheless, draw upon the University faculty in its work, in addition to having its own staff of technicians and scientists.

One example of the engineering research and development organizations recently organized is Engineering Research Associates, Inc., in Minneapolis. At the close of the war, a group of scientists and engineers who had worked together in the Navy resolved to continue their research and development as a private enterprise. Engineering Research Associates was incorporated January 8, 1946, supplementing the technical skills and training of the group with the management, fiscal organization, and facilities of the Northwestern Aeronautical Corporation. At the present time Engineering Research Associates has offices in Washington, D. C., as well as in Minneapolis, has a staff numbering 450, and is carrying out research and development work under contracts amounting to more than $3 million annually.

The primary objectives of Engineering Research Associates are in the fields of research and development. However, in order to insure that research and development will lead as far as possible toward public benefits, the organization undertakes certain limited production of equipment that gives a strong impetus to the practical solution of research and development problems.

More than at any time in the past years, both industry and government are "farming out" their research problems to organizations of the type discussed above. It is becoming increasingly evident that the role of the independent research organization will be a responsible one indeed. To them industry looks for a substantial part of future industrial progress, a greater production of better products at reduced cost, opening new avenues of better living to all people.

The Government In Research

Before World War II our federal government paid about one-fifth of the nation's research costs, while industry, research organizations, universities and colleges financed the remainder. The war brought about a complete reversal of this situation as industry concentrated on production and the government spent greatly increased sums for the development of existing weapons and the discovery of new ones.

Since the war, governmental expenditures for research have dropped less than one-third while industry has increased from its $80 million annual outlay for research during the war to a figure six to eight times that amount. According to the Report of

(Please turn to page 50)

WHEN *YOU* and BOB HOPE *RELAX* . . .

WHETHER you shoot golf in the low 70's, like Bob "Hole-in-One" Hope, or celebrate when you break 100, you'll find Pabst Blue Ribbon Beer is always a pleasant, friendly companion.

That ever-faithful, *real beer flavor* you enjoy in Pabst Blue Ribbon was achieved by 104 years of pioneering in the *Art of Brewing* . . . and the *Science of Blending*.

By tasting, by comparing, you will understand why millions have settled down to the real beer enjoyment that comes with blended, splendid Pabst Blue Ribbon.

Tune in the EDDIE CANTOR Show Every Thursday Night over N B C.

33 FINE BREWS BLENDED INTO ONE GREAT BEER

Pabst
Blue Ribbon

(Continued from page 48)
John R. Steelman to the president, the government spent approximately $625 million for research in the fiscal year 1947, exclusive of the atomic energy budget. Today there is little difference between the annual expenditures for research by government and by industry. Steelman estimated research expenditures by industry at $450 million, but others feel the total is probably higher and might reach $600 million or possibly even $700 million. Whatever the relative expenditures may be, it is evident that the federal government has greatly increased its expenditures for basic scientific knowledge and the application of that knowledge, and that expenditures are likely to stay very high.

The government owns and operates research facilities valued at approximately $1.5 billion, not including atomic energy development and production projects which probably double that figure. Thirty thousand scientists are now employed directly by the government and there are some 60 agencies which have distributed projects through all forty-eight states.

Mr. Steelman, in Vol. II of *Science and Public Policy*, gives the Federal research expenditures, by agency, for the fiscal year 1947 as follows:

Navy Department	$262,000,000
War Department	237,000,000
Agriculture Department	31,328,000
Interior Department	30,358,000
Natl. Advisory Comm. for Aeronautics	27,000,000
Federal Security Agency	13,236,000
Commerce Department	10,494,000
Federal Loan Agency (R.F.C.)	4,699,000
Tennessee Valley Authority	3,654,000
Veteran's Administration	2,523,000
Federal Works Agency	822,000
Smithsonian Institution	309,000
Treasury Department	220,000
Federal Communications Commission	200,000
Maritime Commission	87,000

It is estimated that, over-all, $570 million of the $625 million spent by government was used for applied research and development. Further, it is estimated that $465 million out of $500 million spent by military agencies was for applied research and development.

Of the $625 million spent on research, government owned laboratories did only about $200 million of the work. The remainder was done by industrial laboratories, by research organizations and by universities and colleges. Merely directing the program of government research has become a major operation, yet it is expected that the federal budget for research will be increased by at least two-thirds and possibily doubled within the next ten years.

The photomicrograph, made at Armour Research Foundation, shows a thin film of Vitamin K taken with crossed nichols to bring out twin bands and other structural features. Studies of this type are quite useful in optical crystallographic work.

Whenever private industry is unlikely or unable to pursue research urgently required in the nation's interest on an adequate scale, the federal government and the state governments must take the responsibility. For example, prior to the war, research and development in agriculture consumed a large part of the research budget; individual farmers cannot afford to do research, yet the improvement of their methods and the search for new and basic scientific information in agriculture is vital to the nation's interest. In the 1946 report of the administrator of agricultural research, it is stated that from a total investment of $10 million in research on hybrid corn, the nation is now collecting annual dividends of at least three quarters of a billion dollars. Research on small grains by federal and state laboratories is believed to have added half a billion dollars each year to the national wealth. An investment of less than one million dollars in sugar cane research has increased the annual value of sugar cane crop by more than $20 million.

In addition to research for the development of the nation's resources, to further its basic industries, for public health, for public safety, for the maintenance of adequate and reliable industrial technical standards and for the development of precision scientific standards, the government now has the responsibility to support basic and applied research necessary to maintain our military security. The international situation since the close of the war has necessitated the continuation of research in this direction.

It is generally agreed that authority granted by Congress to the various

departments and agencies is sufficient for the establishment of a sound research and development program. A large part of the funds granted under this authority are now used to sponsor research in industrial or university laboratories, and such support will likely be expanded in the future.

Government research and development expenditures during the war were 83% for the military agencies. The percentage remains about the same since the war. During the war an emotional factor welded science and the armed forces into a victorious team. Now the emotional factor, although not gone, is considerably lessened even though the percentage of government funds being spent for military research and development has remained about the same. This is the problem with which the military agencies, much more enlightened and recognizing for the first time the absolute necessity for scientific research, is faced.

Research and development units in the army, navy, and air force are not new things but they are new "big" things. Branches of the military have a new awareness of the necessity for research and development. Such an awareness is made evident in their research programs and their determination to push those programs to completion. Examples of this attitude may be seen in talks delivered before the Engineering College Research Council meeting in Washington in November 1947 by Admiral Paul P. Lee, chief of the Office of Naval Research; General H. S. Aurand, research and development director of the Army; General L. C. Craigie, research and development director of the Air Force; and Dr. L. R. Hafsted, executive secretary of the Research and Development Board, National Military Establishment. In the words of Admiral Lee, "The war demonstrated most forcefully that the security of the United States is, to a very large degree, dependent upon our national scientific strength. It is demonstrated that from purely basic research studies comes knowledge which can have a profound effect upon the conduct of war. It is demonstrated that the civilian scientist and the man in uniform must work together if they are to apply our scientific knowledge to problems of national security".

Admiral Lee stated that the Navy Department has under contract "something over 600 research projects in about 100 universities and nonprofit laboratories. By the end of this fiscal year we will have obligated over $50 million for the support of this program. We have planned to stabilize it at an annual expenditure level of $22 million."

General Aurand stated that, under the direction of the Research and Development Division of the army, "the technical services have at present contracted for 605 basic research investigations, roughly 10% of which are being carried on by universities and colleges".

General Craigie said, "at present there are 54 universities engaged in research and development work for the Air Forces, working under 242 contracts. These contracts cover research projects for the 12 different laboratories of the Air Material Command, and represent more than 10% of the 1947 research and development funds".

The National Research and Development Board, represented by Dr. Hafsted at the Engineering College Research Council conference, is a new organization, but it is actually an outgrowth of the Joint Research and Development Board chartered during the war, established to avoid duplication of efforts.

John R. Steelman states in his report to the president that "it is vital that the funds for basic support of research be administered with the advice of an imaginative group of scientists". Here Steelman is alluding to the National Science Foundation. Congress passed, but President Truman disapproved, a bill for the establishment of such a foundation during the 80th Congress. There was, and is, controversy on the advisability of creating such an organization. In his Memorandum of Disapproval, dated August 6, 1947, the President gave as his reason for disapproval the fact that the representative group of scientists was given full responsibility for the administration of the Foundation. In his message the President said the role of the scientists should be "more appropriately one of advisory nature rather than one of full responsibility."

To quote the Steelman report on the matter of the Foundation: "It is . . . recommended that the Congress be urged to establish at its next session a National Science Foundation within the Executive Office of the President and that the Foundation be authorized to spend $50 million in support of basic research its first year, with increasing amounts thereafter rising to an annual rate of at least $250 million by 1957. No restriction should be placed on the fields of inquiry eligible for support.

"The National Science Foundation should be headed by a director appointed by the president and assisted by a part-time advisory board of distinguished scientists and educators similarly appointed. It is recommended that this advisory board be appointed half within the government and half without. The federal government's share in the national science program makes it imperative that the government's scientific agencies be represented in the planning of the basic research program.

"Moreover, a portion of the monies expended in support of basic research should take the form of grants from the government's scientific bureaus and agencies themselves. This is an important means of strengthening contacts between the government and private scientists, of keeping both groups informed of work in progress, and of strengthening our total scientific effort.

"It is clear that a portion of the funds expended by the National Science Foundation should be used to strengthen the weaker, by promising colleges and universities, and thus to increase our total scientific potential."

Later in his report Steelman states:

"While the large role contemplated by the federal government

(Please turn to page 52)

(Continued from page 51)
will not necessarily be reflected in a comparable increase in federally-owned and operated facilities, considerable increase is desirable."

And further: "Except in event of military emergency, it is unlikely that the Federal Government will have to finance the necessary expansion in industrial research facilities. We should have a favorable climate for such expansion through tax incentives and other established methods, without making direct grants to industry."

When the bill for the National Science Foundation came up for debate in the 80th session of Congress, it met some opposition from research men in industry and in private research organizations. The opposition was directed against the government's engaging in research and was based on the tenet that basic research could best be promoted by tax incentives to industry to induce them to finance fundamental scientific research.

Opposition to the passage of the bill also was based on the belief that greater diversity in research activities and freedom from political influence can be obtained only by encouraging private enterprise to furnish funds.

A bill introduced into the 80th Congress on February 5, 1947 would have made the Department of Commerce a clearing house for scientific and technical information. This bill died in committee. It was not revived although certain portions of it reappeared in the National Science Foundation bill.

It is very likely that legislation will be introduced in the next congress to create a National Science Foundation, and it is not unlikely that necessary legislation to make the Foundation a reality will be enacted. It is also not unlikely that legislation will be reintroduced to create more extensive authority for the Department of Commerce to provide a technical service to industry.

Research In The International Field

Although American firms have studied the products and resources of foreign countries in their own laboratories, seeking new sources of supply for raw materials and seeking new products for development, few of them have conducted scientific investigations in the foreign field. It is true, of course, that other firms have provided engineering and technical assistance on a consulting basis to foreign governments and industries, and in this manner a considerable amount of American technology has been exported.

In 1942 the Corporation para la Promocion del Intercambio of Argentina commissioned Armour Research Foundation in Chicago to conduct a study of Argentine industries for the purpose of:

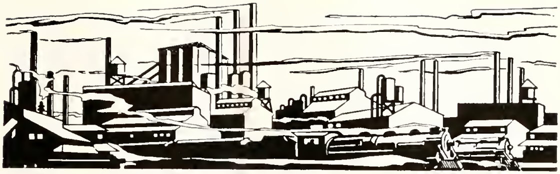
1. Discovering ways in which scientific research can best be applied to the improvement of Argentine products already in production.

2. Discovering ways in which scientific research can be undertaken toward increasing or creating demand for Argentine raw materials.
3. Discovering ways in which certain Argentine raw materials can be used to alleviate shortages within the country.
4. Calling attention, where possible, to opportunities for applying known technology which might have been overlooked in the conduct of some Argentine industrial and agricultural operations.

Specifically studied were jute, hides and leather, minerals, dairy products, grains, chemicals, forest products, vegetable oils and fuels industries. The survey in many respects formed a pattern for similar studies which may be made for Argentine and other foreign countries and has led to the development of a number of helpful procedures.

To help develop an orderly program of industrialization in certain fields of Mexican endeavor, and to promote the development of industrial technology in Mexico, Banco de Mexico undertook in 1945 a coordinated series of studies in fields associated with its diversified responsibilities and the national interest. At the instigation of its Director General, Banco de Mexico requested Armour Research Foundation to make a technological audit of major areas of Mexican industrial activity, including coal, coke and other solid fuels and by-products, hides, leather, hard fibers, and forest products in general, together with related industries and associated activities in agriculture, technical education, and research.

The basic survey was completed and published at the end of 1945, but numerous special research projects and laboratory investigations were continued well into 1946. In April of 1947, Banco de Mexico arranged for a new and expanded program. Projects now in progress include: evaluation of a packing house by-products industry in Mexico; a comprehensive study of fats and oils native to Mexico as raw materials for both new and established industries; evaluation of fluorspar deposits with a view toward their benefication, and the stablization and nutritional improvement of the tortilla masa.



Countries in Central and South America are becoming more conscious of the essential role that technology and research can play in the improvement of living standards for their people, in the impetus toward industrialization, and in the futhering of their national economy. Fortunately this view is beginning to be shared by leaders of government, industry and banking everywhere.

Financial and government leaders in the United States are also recognizing that scientific knowledge, research skills, and technological knowledge form an important export commodity to assure a continued supply of raw materials for our industry, to maintain an active foreign trade, to provide for hemispherical security, and to increase the standard of living for our country.

The Management Of Research

Research management and organization have their own peculiar and characteristic problems. That this field of management is attracting great interest at this time is verified by the several conferences on research management held during the year, and by the great interest in graduate courses and seminars on the subject.

The Engineering College Research Council held a well-attended three-day meeting in Minneapolis in June of 1947. Great interest was shown by a large attendance of industrial, university and government representatives. Proceedings of this conference, as well as the previous one held under the same auspices in 1946, are published in booklet form.

Pennsylvania State College conducted a conference on Research Management in October of 1947, again very well attended by numerous representatives of industrial laboratories, universities and government research agencies. Proceedings of the conference will be available early in 1948.

The Industrial Research Institute regularly holds two or more conferences each year to consider the many problems connected with operation of research laboratories in industry.

Graduate courses and seminars on research management, pioneered by New York University, have been continued at that institution, and have been conducted at Illinois Institute of Technology and at Pennsylvania State College.

Such conferences have emphasized the fact that management of research cannot be fitted into a definite pattern even to the extent possible in most fields of management, and that each laboratory with its peculiar conditions of personnel, objectives, and background presents a unique situation taxing the utmost skill, ingenuity and understanding on the part of its management to secure maximum creative productiveness. The growing shortage of technical manpower will make even more difficult the problems of management, since the skills, abilities, experience and knowledge of able scientists must be spread even thinner over the rapidly multiplying and increasingly complex problems brought to the laboratory for solution.

Research In Management

The place of research in management is receiving an increasing amount of attention and interest. Dr. Raymond Stevens, vice president of Arthur D. Little, Inc., pointed out *(Please turn to page 54)*

(Continued from page 53)
before the June 1947 meeting of the Industrial Research Institute that it was not uncommon a short time ago for management to be divided into three parts: production, sales, and finance, with the head of the organization either a production, sales or financial man depending upon force of personality or family inheritance. The three parts were the complete triumvirate of management.

"Research is now being accepted as a portion of this policy-and-decision-making group". Dr. Stevens continued. "Today's research director may have the same title as that of thirty years ago but he has much greater responsibility."

There is a decided trend to make the chief research officer a part of top-management, frequently with the title of vice president, and to depend on him to take a prominent part in policy decisions. Dr. Stevens suggests that the research director must:

1. Know and help formulate the over-all future policy of the company.
2. Plan for products and processes leading in the right direction.
3. Not only explore scientific and technical areas but examine markets, patents, costs and competition.
4. Be as thorough in his economic as in his technical examination of a new development.
5. Create and prove new products and processes that will reach an attractive market, be free of patent or other important restriction, meet competition, and make a profit.

Maurice Holland, Industrial Research Adviser, reports a recent survey on *What Management Expects of Research* and lists the following in the order rated by the management of several companies:

1. New products.
2. Maintenance of competitive technical position.
3. Cutting production costs.
4. Sales volume and net profit on new processes and products.
5. Serve production through development of new and improved processes.
6. Be on the level or in advance of the best managed laboratories of the leading companies.
7. Operate like other departments of the company, not as "prima donnas" of special privilege.
8. Serve the chief executive in long range planning.
9. Demonstrate the dollar value of research.
10. Assist sales with technical service.

Thus research in industry, and its place in the corporate structure, is becoming more than a mere "fact-finding" unit concerned solely with scientific exploration. As the fountain head of new products, processes, and developments, it has an important place in determining long range industrial policy and in providing a needed service to production, sales, and distribution as well as an advisory service to financial management. Industrial recognition of this new role is unmistakable.

Technical Words

(Continued from page 17)
ing the eyelids), *alkali* (Arabic for calcined ashes, related to the verb meaning *to fry*), *camphor* (traced all the way back to Sanskrit), *naphtha* (of uncertain oriental origin), and *quinine* (from the Peruvian word for bark of a tree). *Nicotine* is one of the few chemical substances named after an individual — Jacques Nicot, French ambassador to Portugal, who introduced tobacco into France in 1560. Native Germanic roots appear but infrequently, in words of basic or many meanings such as *heat* or *crack*, or in strays such as the verb *sinter* (cognate with *cinder*).

The ratio of Latin to Greek loans in physics is comparable to that in mathematics, rather than in chemistry. Latin to French to English is a most frequent line of movement. Such basic monosyllables as *flux, force, lens, power, sound,* and *stress* are of Latin origin, worn smooth of suffixes by centuries of handling in English. *Nucleus, pendulum, spectrum,* and *vacuum,* of later arrival, show their classical origin more plainly. The basic language of physics is widely known, which is to say a large group of Latin borrowings is widely known — *motion* and *temperature, gravitation* and *volume, attraction* and *velocity,* to cite a few at random. The Greek element, though much smaller, contains such familiar items as *atom, energy, gram, meter,* and *prism,* as well as rarities such as *entactic* and *laogonic* and recent adaptations such as *dyne* and *erg. Lever, gage, battery,* and *buoyancy,* appearing in that order, represent a small French element in physics. Teutonic survivals include terms for spatial dimensions *(depth, width),* a couple of fundamental terms in mechanics *(gear, shear),* and the ancient *speed* and not so ancient *stretch.*

In that part of physics concerned with electricity and magnetism, Latin is the major source for words, as we would expect from precedents. From *antenna* and *armature* through *lamination* and *motor* to *terminal* and *transmit* — all through the electrician's alphabet Latin stems abound as the largest group from a single origin. Large numbers of Romance stems were immediately from French; a sharp line between Latin and French borrowings is especially impracticable here. *Electric* itself is from the Greek word for *amber,* the substance in which electrical attraction was first observed. Related words have followed *electric* (1600), with Franklin contributing *electrify* and *electrician,* and with *electricize* (1872) as a relatively young addition. Familiar borrowings from Greek include *anode, dynamo, static,* and *telephone. Damp, ground, lightning, short, spark, wave,* and *wire* are from native Germanic roots, some of which have obviously undergone extension of meaning. Electricity lacks exotics, but is perhaps the field in which proper names figure most conspicuously. Familiar to electrical workers are the names of the Frenchmen Ampere and Coulomb, the Italians Galvini and Volta, the Englishmen Faraday, Joule, Watt, and Wheatstone, and the Germans Gauss and Ohm. Ingenuity has been at work, and for a unit of conductance, the reciprocal of resistance *(ohm), mho* has been established. The backward spelling *daraf* is less well-rooted. *Radar,* made up of initials, offers no possibilities for inversion.

The passage from electrical to mechanical engineering is a passage from the relatively newly discovered to what is to a considerable extent centuries old. Of all the subject matter fields here considered, only machinery provides a place where Germanic derivations approach in frequency the Latin-French borrowings. Germanic forms such as *mold, nail, ore, shaft, tool, wedge,* and *wheel* have been in English for over a thousand years. Many more are long-lived northerners: *hammer* and *tongs; anvil, shank, spindle,* and *stud; wrench, weld, clutch;* etc. These are no ink-horn terms introduced by pedants. Though Latin loans *disk, spike,* and *die* are homely enough, others betray recent and academic importation: *centigrade* and *crucible, ferrous* and *ignition, lubricant* and *torque.* Greek figures far less— *automatic, eccentric,* the *therm* family, and a few others.

A sampling of metallurgical terms shows general linguistic sources in the following order of frequency: Latin-French, first by a great margin; Germanic roots, a decisive second; Greek, a poor third. Yet *metallurgy* itself goes back to Greek origins. Germanic stock includes *cast, froth,*

melt, ore, oven, slag, and *smelt.* Words entering from French include *alloy, forge, foundry, roast,* and *volatile,* while others have more immediate contact with Latin origins: *amalgamate, centrifugal, precipitate,* and *resilience.*

Greek figures prominently, however, in the language of meteorology. The weather has been talked about for a long time. *Cloud, drizzle, mist, rain,* and *wind* go back in unbroken line to Old English, and *hail, snow,* and *hoarfrost* have been traced to the pre-historic continental Teutons. The learned jargon, though, is classical, as is characteristics of all branches of science. Besides general terms which happen to appear in meteorological language, Latin contributes the cloud names—*altocumulus, cirrus, fractostratus, noctilucent.* Greek items are largely highly technical—*nephology* (the study of clouds), *isotherm, pyrheliometer, troposphere*—though *climate* and *cyclone* are familiar enough, and *atmosphere, thermometer,* and *meterorology* itself have been thoroughly popularized. Of particular interest are Arabic *monsoon* and *typhoon* and Spanish *hurricane* and *tornado,* showing as they do a correlation between geography and vocabulary. *Blizzard* and *chinook* are American contributions, as are many phrases.

The dominance of Latin and the prominence of Greek, repeatedly cited above, are far more characteristic of scientific than of colloquial English or of non-scientific specialized vocabularies. The fields of law and music present a distinct contrast in origins. In law, there is a large group of words that are unmodified French. Latin and French, thanks to Roman law and the Norman Conquest, dominate the field, to the almost total exclusion of Germanic and Greek derivatives. In music, Italian is the international tongue, with notations on musical scores uniformly in unaltered Italian. Middle English, French, Latin, and Greek, in falling order, have likewise fed into modern English musical vocabularies.

So far we have largely isolated the question *whence?* To answer briefly the question *when?* is to

glance at the chronology of science.

Mathematics is an ancient study, but its time of most rapid expansion was shortly after the Renaissance. Billingsely in the sixteenth century and Descartes, Napier, and Leibnitz in the seventeenth did much to enrich the vocabulary of mathematics. Physics has a core of terms reaching far back, and also experienced a considerable seventeenth century expansion, but it has had its greatest burst of vocabulary additions since the nineteenth-century triumph of the industrial revolution. Chemistry was most prolific of new terms between 1850 and 1880; only a negligible part of its present vocabulary existed in English before 1600.

There is a marked correlation between language of origin and date of entry. Words of native Germanic stock were, for the most part, an integral part of emergent modern English of medieval times. Latin has been drawn upon constantly, but forms coming by way of France cluster around the Renaissance, while still scholarly borrowings, complete with Latin case endings, are for the most part from the nineteenth century or later. The Greek element (except in mathematics) is thoroughly discontinuous, consisting of late (nineteenth and twentieth century) artificial borrowings.

As an illustration of the steady influx of Latin stems, consider this sequence from mathematics: *prime* and *line* (by 1000, though not in a specifically mathematical sense), *division* (1430), *triangle* (1525), *binomial* (1557), *rectangle* (1571), *sine* (1591), *decimal* (1608), *quadratic* (1656), *calculus* (1672), *tractrix* (1727), *catenary* (1788), *folium* (1848), and *radian* (1879). Greek, too, is a continuously mined vein in mathematics: *sphere* (1300), *theorem* (1551), *polygon* (1570), *trigonometry* (1595), *logarithm* (1614), *asymptote* (1656), *hyperbola* (1868), *ellipse* (1753), *conchoid* (1798), and *strophoid* (1880). With the dates of these mathematical terms, contrast the surprisingly short life of the following basic chemical terms from Greek: *hydrogen* (1791), *phosphorescence* (1796), *catalysis* (1836), *electrolysis* (1839), *colloid* (1847), *picric* (1852), *kerosene* (1854), *osmosis* (1867), *octane* (1872), *proton* (1893), *isotope* (1913). Chemists' Latin occasionally shows some longevity—*precipitate* (1594), *emulsion* (1612), *capillary* (1664), *effloresce* (1775). But chemistry is essentially a newcomer.

Especially in applied science, the vocabularies are largely built up by the appropriation for technical meanings of words earlier naturalized. The mechanical engineering sampling, for example, showed the most populated centuries of entry in *any* meaning to be the fourteenth, fifteenth, and sixteenth, in that order. More *technical* meanings, however, appeared in the nineteenth century than in any other. In metallurgy, the leaders were again the fourteenth and the nineteenth, respectively. In the ancient art of surveying, the seventeenth led in both respects; the fourteenth was a good second in *any* meaning, but fifth in surveying senses. An especially notable instance of borrowing from naturalized sources is photography, a field so new that *photography* itself was not coined until 1839. *Negative, plate, positive, print, sensitive,* and *sharpness* had all been in the English language for five hundred years before they took on photographic senses. In contrast, the legal vocabulary experienced its most rapid growth between 1550 and 1650, and experienced an increment of little more than 10 per cent during the nineteenth century.

This treatment can only faintly suggest the wealth of historic detail *(Please turn to page 58)*

(Continued from page 57)

that a student of technical language may discover. Behind every word there is a story, eloquent in some degree of the intellectual experience of English-speaking peoples.

So much for place and date. Meaning is best of all. The familiar meanings and the figures of speech implicit in technical terms can afford almost limitless entertainment and insight.

Area, calculus, and *cubes* are now names of intangibles, but originally their roots meant, respectively, vacant property in a town, a small stone, and dice. There is much natural history—and scientific history, too — hidden in mathematics and chemistry. *Cissoid* and *conchoid* are Greek for ivy-like and mussel-like; *limacon* is French for snail-shell; and *lens* comes from Latin for lentil. Many chemicals are named after ancient names for original natural sources: *aconitine* from the scientific name of wolfsbane; *allyl* from garlic; *amyl* from starch; *codeine* from poppy-head; *formic* from ants; *hippuric* from horse's urine; *malic* from apples; *opium* from poppy juice; *methylene* from wine of wood; and *phlorizin* from root-bark. *Viscous* goes back to a sticky bird-lime made of mistletoe berries. *Capric* refers to goats; *crystal* to clear ice. *Miniscus* means little crescent, a diminutive of the Greek word for moon.

A strangely immortalized bit of history is represented by the chemical name *cinchonamine* ($C_{19}H_{24}N_{20}$). The Countess of Chinchon, a Spanish dignatary in Peru, was cured of malaria in 1638 by the use of a bark that bears this alkaloid.

Numerous hard chemical words make descriptive sense when translated from Greek — *allophanic,* appearing otherwise; *atmolysis,* vapor-releasing; *cacodyl,* stinking; *catalysis,* down-loosening; *chlorine,* light green; *chromogen,* color-bearing; *colloid,* glue-like; *creosote,* flesh-preserver;

endosmosis, inward-pushing; *glycerine,* sweet; *myristic,* ointment; *narcotic,* benumbing; *phosphorescence,* light-bringing; *picric,* bitter; etc. *Phenicine* refers to Phoenicia; it is the technical name of the famous Tyrian purple dye.

Translation explains other kinds of scientific words, too: *asymptote,* not falling together; *subtract,* draw off; *tangent,* touching; *nucleus,* kernel; and *friction,* rubbing. *Orifice* is from the Latin words for *mouth* and *make; lever* is French for *to raise. Focal* goes back to fireplace or hearth. The most distant root of *engineer* is Latin for *to beget*—now extended from progeny to artifacts. The disguise of some loans is easily pierced: *centrifugal,* center-fleeing; *goemetry,* earth-measure; *kinetic,* moving; *synthetic,* put together; *telephone,* far-sound.

But there is figure as well as fact in etymology. Mathematics has its implied comparisons: *cardiod,* heart-shaped; *catenary,* chain-like; *folium,* leaf; *line,* linen thread; *sine,* bend; *trapezoid,* table. Chemists drew on Greek mythology to name poisonous *atropine* after one of the Fates and *morphine* after the god of sleep. The *capillary* tube is hair-like; *corrosion* is intense gnawing. There is dead metaphor in the electricians' *impedance* (shackled feet) and *insulate* (make an island).

Semantic change is present, too. The root of *furnace* once meant *oven,* while that of *chimney* meant *furnace.* Latin *galleta,* the source of our *gallon,* meant wine-measure. That word has become generalized; *turbine* is an instance of specialization. The Latin noun *turbo* meant anything turning, from a cyclone to a child's top. *Matter* itself, the subject of physical science, takes its name from Latin *materia,* which originally simply meant wood for fuel or building.

So it goes. Language is a complex symbolism, a mirror in which we may catch countless reflections of the movement of all kinds of human thought and endeavor, a mirror in which we may discover innumerable gleams of meaning which we would never have found if we had not looked for them.

Contributors . . .

(Continued from page 4)

in 1941. From 1941 to 1944 he was a member of the admissions staff at Lawrence and in 1944 received a master's degree at the University of Chicago. He became director of admissions at Illinois Tech in 1944. In September, 1946, he was appointed dean of students. Just 29-years-old at the time, he was believed to be the youngest dean at any major educational institution in the country. He is a member of Phi Delta Kappa honorary educational society, Delta Tau Delta social fraternity, and Alpha Phi Omega, and a number of professional organizations.

Naval Architecture . . .

(Continued from page 20)

1 Wave Length, ½ wave length, ¼ wave length, and ⅛ wave length. The conductor thus absorbs power which is evidenced in the heat absorbed and given off. Any wave length multiple less than ⅛ can be considered negligible from the standpoint of energy absorption.

The speed at which an electromagnetic wave travels is equal to the velocity of light, or 300,000,000 meters per second, and the distance which it will cover in one cycle will be equal to this velocity divided by the frequency in cycles per second, or the

$$\text{Wave Length} = \frac{300{,}000{,}000 \text{ meters}}{\text{frequency}}$$

Therefore, Wave Length X frequency = 300,000,000 meters per second. Wave Length X frequency $= 300 \times 10^6$.

The radio frequency output of the United States Naval Radio Station is classified as high frequency, from three (3) or 3×10^6 meters to twenty-five (25) megacycles, or 25×10^6 meters.

$$\text{Thus, Wave Length} = \frac{300 \times 10^6}{3 \times 10^6} = 100 \text{ meters}$$

$$\text{Wave Length} = \frac{300 \times 10^6}{25 \times 10^6} = 12 \text{ meters}$$

At 100 meters, the multiples of wave length are:

$$\frac{100 \times 39.37''}{12''} = 328 \text{ feet}, \frac{328}{2} = 164 \text{ feet}, \frac{328}{4} = 82 \text{ feet}, \frac{328}{8} = 41 \text{ feet}$$

At 12 meters, the multiples of wave length are:

$$\frac{12 \times 39.37''}{12''} = 39.37, \text{ say } 40 \text{ feet}, \frac{40}{2} = 20 \text{ feet}, \frac{40}{4} = 10 \text{ feet}, \frac{40}{8} = 5 \text{ feet}$$

From the above calculations, it is determined that any metallic objects more than five feet in length and coinciding with the various multiples in the frequency range, being the electrical resonant equivalent, will absorb radio frequency energy.

Therefore, all steel reinforcing rods, although primarily calculated for strength requirements to carry the roof loads, and the weight of the materials of construction, and to withstand earthquake or blast, are rigidly and continuously bonded to ground in order to eliminate any standing waves which would otherwise occur. Should any bond connection be broken or be incomplete at both ends and be of a length equivalent to any multiple of one-half a wave length, heating can be expected.

It becomes apparent that to insure an adequate and rigid bonding of the reinforcing rods and other metallic items, that welding or brazing is specified to form a continuous unbroken metallic electrical path to the ground bus. The arc welding or brazing method has been adopted for bonding, not only because of the adequate power supply available at the site—the standby power diesel engine generator—but it has clearly demonstrated its feasibility in field work. It appears to be the most suitable means for getting at the intersections of the complex and sometimes tightly knit network of the reinforcing rods to produce a bond to withstand the vibrations of concrete as it is being poured or the jars which may be due to blast or earthquake.

The Specifications for the United States Naval Radio Transmitting Station read in part as follows:

Section 21. Grounding

21-01. General requirements.—The work includes the grounding of all metal and equipment in the Transmitter Building.

21-02. *Materials to be grounded* include all structural steel, concrete reinforcing steel, ladders, wire mesh partitions and doors, anchors, curb angles, gravel stops, gutters and down-spouts, metal lath and studs, metal windows, metal and metal-covered doors and their frames and forms, metal frame screens, bolts, metal ducts, electrical wiring conduits, metal railings, piping, metal thresholds and all other metal used in the construction of the building, except nails and screws. Care shall be taken so that the trench covers and trench curb angles shall make a good electrical contact and that no paint shall be placed on the trench curb angles or on the underside of trench covers. At all points where grounding connections are made, the metal shall be cleaned of all paint, rust, dirt, grease and scale. In general, the only means considered satisfactory for bonding steel members for grounding is by welding or brazing. Painting specified under another section shall not be applied until after the grounding connections have been inspected and approved.

21-03. *Grounding of reinforcing steel.*—All reinforcing steel in the Transmitter Building, including main bars, temperature bars, fabric mesh, bar supports, spacers and stirrups shall be inter-connected by welded joints and bonding wires, to provide a continuous metallic electrical path to the ground bus. All bonding between reinforcing bars shall be No. 6 BWG black steel wire of sufficient length and so placed as to prevent any tensile stress in the wire. Lap splices in bars forming an electrical path to ground, specified to be welded at every intersection, shall be made electrically continuous by bonding across with a No. 6 BWG wire welded to each bar. Any isolated reinforcing bar shall be grounded by bridging with a bonding wire to an adjacent grounded rod or other grounded metal part. Above every window or wall opening, all vertical bars shall be welded to a horizontal bar that is grounded by bonding to a grounded vertical bar.

All vertical bars in each face of wall shall be welded to the one above or below to make a continuous electrical path from cornice to foundation. Weld all horizontal bars to either of these vertical bars on column centers to assure that each bar is grounded at least once in each bay. All vertical bars in walls shall be welded to the 1 inch square bars at

(Please turn to page 62)

The next time you hear voices —LISTEN!

IT MAY BE your conscience speaking.

It may be saying: "Save some of that money, mister. Your future depends on it!"

Listen closely next time. Those are words of wisdom. Your future—and that of your family—*does* depend on the money you put aside in savings.

If you can hear that voice speaking clearly, do this:

Start *now* on the road to *automatic* saving by signing up on your company's Payroll Savings Plan for the purchase of U.S. Savings Bonds.

There's no better, no surer way to save money. Surer because it's automatic . . . better because it pays you back four dollars for every three you invest.

Do it *now*. If you can't join the Payroll Savings Plan, tell your banker to enroll you in the Bond-A-Month Plan that enables you to purchase a bond a month through your checking account.

Remember—better *save* than *sorry!*

Automatic saving is sure saving— U.S. Savings Bonds

Contributed by this magazine in co-operation with the Magazine Publishers of America as a public service

(Continued from page 60)
first floor elevation to form a girdle around building.

In roof slabs, weld all bars on column centers (in slab and beam) to all crossing bars; at walls, connect all horizontal bars to vertical bars.

On main and second floor, connect all bars on center-line of columns to crossing bars. At walls, connect all horizontal bars to vertical bars. At columns, connect one vertical bar to floor reinforcing, bonding all other reinforcing to this bar.

21-04. *Grounding of conduit.*—All outlet boxes and panel boards shall be bonded to reinforcing steel. All conduit shall be bonded at least every 20 feet either through an outlet box or by direct bonding to reinforcing steel.

21-05. *Grounding of equipment.*—All electrical equipment, except as noted, shall be considered sufficiently grounded through its conduit connections. Care shall be taken to maintain the electrical continuity of the conduit system to the equipment to be grounded. Mechanical equipment, not mounted on an integral metal base with electrical equipment, shall be grounded separately. Minimum ground connections shall be No. 6 bare copper.

21-06. *Grounding of metal doors and windows.*—Door and window frames shall be bonded to the wall reinforcing. The doors and windows shall be considered sufficiently grounded through their hinges.

21-07. *Grounding of miscellaneous steel and metal work.*—All inserts, anchor bolts, angles, columns, channels, sleeves, sheet metal work and other metal work shall be grounded to the reinforcing steel by welding, or brazing. Removable trench cover plates shall not be grounded. Angles and other metal longer than 10 feet in length shall be grounded approximately 10 feet on centers.

21-08. *Grounding.*—The grounding system in trenches consists of a network of $\frac{1}{8}$ x 2 inch copper bars supported as shown on the drawings.

Ground rods shall be $\frac{5}{8}''$ x 10 feet copper-covered steel, with No. 2/0 stranded copper cable connecting them to the reinforcing steel. All connections between copper and reinforcing steel shall be brazed.

21-09. Concrete and masonry work, containing metal work imbedded therein, shall not be performed until grounding of metal work has been inspected and approved.

By proper bonding and grounding of the steel reinforcing rods, metal doors, window frames, and the like, which are used for the construction of a large high frequency radio transmitter type of building, no reflections, or standing waves and, consequently, heat absorptions are present.

The effects of standing waves may be summarized as follows:

(1) A personnel hazard, due to electric shock or burning; (2) an absorptive factor in using power needlessly, resulting in power waste; (3) a heat factor, causing an expension of steel reinforcing rods at a greater rate than the enveloping concrete, and weakening the concrete bond and endangering the structural effectiveness of the building, and (4) a maintenance factor, causing hair-line cracks and flaking of the concrete and adversely affecting the architectural appearance.

In addition to arc welding or brazing the network of reinforcing rods and ground bus bars, bonding wires are used as a by-pass for radio frequency across the steel and ground bar lacework. If for any unforeseen reason there should be an incomplete rod connection, or should a broken bond occur by reason of the vibrating methods which are used to obtain a greater strength concrete, the stray radio frequency energy can be efficiently carried off by an unbroken metallic network to the ground.

In ordinary reinforced concrete construction, tie wires serve to hold the steel rods in place as the concrete is being poured. In this design the tie rod serves primarily as a rod spacing and holding method for the welded connection. Should the spacing between rods come out in multiples of one half the radio frequency wave length and should the bonds be broken at both ends, then the rods will have the tendency to act as an ungrounded antennae and will needlessly use up power.

Additional strength for earthquake or blast resistance of the building is provided by the continuous welded bond of the reinforcing rods. Future design of radio transmitter buildings based on this experience will provide even more economic sections of reinforced concrete, taking into consideration the increased structural strength brought about by the bonded network of reinforcing rods, resulting in greater building economy.

The problem of controlling radio frequency energy in the metallic construction members of the high power, low frequency station is basically the same as that of the high frequency transmitter building; however, it is much greater in magnitude. For this type of proposed construction, copper-coated steel rods, such as "Copperweld", are being considered as reinforcing for concrete. These rods would prove highly effective in rapidly transmitting stray radio frequency to ground without heating up the steel core, because the tendency of electric current at radio frequency is to travel on the outside perimeter of a conductor, particularly one of relatively low resistance, such as copper.

Research is contemplated for high-conductivity metal rods, as well as for copper-coated steel rods, to determine, as follows, their feasibility for use in the reinforced concrete radio transmitter building:

(1) Suitability as concrete reinforcement.

(2) Use as an open metallic reinforcing lacework shielding bonded to a copper ground system at the base.

(3) Suitability of welding together of reinforcement to provide adequate bonding strength, and a continuous "to ground" network.

It is felt that this correlation of applied electronics structural bonding techniques and architecture will prove of interest, particularly in bringing out an improved and economical solution for new electronics structures insofar as military applications are concerned.